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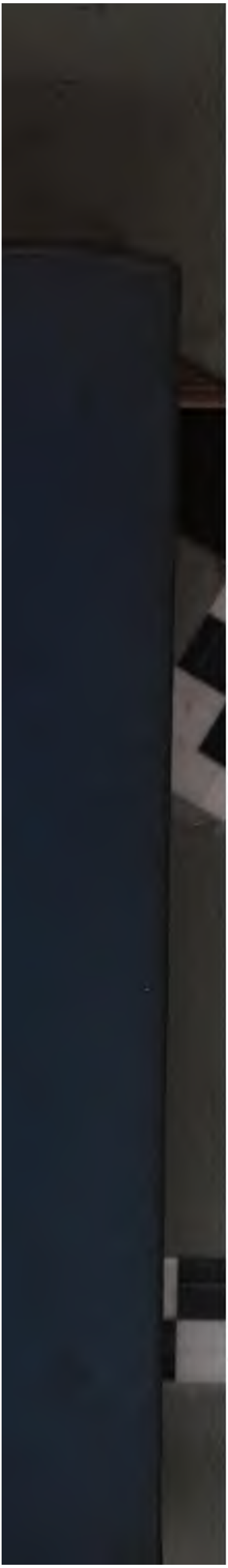

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THE ECONOMIC DISPOSAL OF TOWNS' REFUSE.

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PREFACE.

At this time, when the question of Disposing of Refuse in a sanitary and final manner is engaging the careful attention of so many Sanitary Authorities both at home and abroad, no apology is needed in introducing a work on this subject.

At no time has the question of Sanitary Refuse Disposal received anything like such widespread consideration as at present, and although books dealing with almost every other branch of Sanitary science have been prolific, yet there has been a strange dearth of works on Refuse Disposal. Not only is this so in this country, and in Europe, but in America also. Therefore, in introducing this work to all interested, the author hopes and believes that it will meet a want.

Those who are directly responsible for preserving the public health are usually busy men; their multifarious duties often preclude them from delving very deeply into such a subject, until they are requested to report upon the same to the Council. To such men it is hoped that this work will prove to be of much value.

Previous works on the subject have practically been confined to the Disposal of Refuse in this country. This has been a mistake, inasmuch as refuse is produced everywhere, and, in many countries, climatic conditions tend to make the Refuse Disposal problem even more acute than is the case in this country.

The author has endeavoured, as far as possible, to show how refuse is being dealt with all over the world. American practice, which has previously been entirely ignored, is here dealt with at

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considerable length. In this connection it may be as well to add that, owing to the quick and sudden changes under the contract system of erecting crematories in the United States, slight errors may have crept in. I shall, therefore, esteem it a favour if such are pointed out.

A work of this character must inevitably be, to a large extent a compilation, and it is too much to hope that it can be produced free from error ; any inaccuracy, therefore, apparent to those directly interested, should be notified to the author, who will welcome such corrections and put the same in order as opportunity may offer in succeeding editions.

While no effort has been spared to ensure accuracy, it will be obvious that much of the data and information herein tabulated has been compiled from a great variety of sources. I have specially to thank many surveyors and sanitarians at home and abroad, as also the various destructor makers for their ready and willing assistance. My special thanks are also due to Mr. W. Bamford, of Glasgow, who kindly consented to the inclusion of his paper entitled "Steam Boilers, with special reference to Refuse Destructors," which was read before the Association of Cleansing Superintendents of Great Britain, in Glasgow, last year ; also to Mr. F. W. Brookman, of Rochdale. I am also much indebted to Colonel W. F. Morse, of New York, the distinguished Sanitarian, who kindly consented to write an introduction to the chapter dealing with American practice.

The following of my profession has given me an unique insight into the subject dealt with, and although I think it will be found by the reader that my views upon the practical utility of refuse for the production of power are unmistakably clear, yet I would at the outset point out that I look upon the production of power as the *secondary* function of a destructor, and not its primary duty.

Unless power is produced *after* the thorough destruction of all that is harmful and objectionable, power should not be produced at all. At the same time, I am at one with those who hold that refuse shuold be destroyed by fire, even if there is no power production, or any outlet for using the same even if it is available.

Those, however, who are conversant with our modern practice know that, with the thorough destruction of refuse, power is produced with a properly-designed plant—it is inevitable ; it is but a natural consequence.

Further, just as refuse can only be perfectly destroyed at a high temperature of combustion, so high temperature gases are essential for the production of power. If the material is only imperfectly burned or stewed at a low temperature of combustion then no power is produced worth speaking of.

The late Lord Palmerston once said that "dirt is matter in the wrong place," a very true remark ; needless to add, he did not intend to convey the impression that the right place was a destructor, but nevertheless over 1,000 communities in Great Britain and Ireland, each with a population exceeding 2,000, at this very time keep their refuse in the wrong place from the sanitary point of view.

When comparing the various methods of Refuse Disposal employed all over the world—sanitary and otherwise—it will be readily seen that there is nothing to compare with our modern British practice. We are proverbially slow to move ; the evolution has been very gradual indeed, but there can be no doubt that we have reached a very satisfactory position.

When we congratulate ourselves, let those not be forgotten who made the first efforts to destroy refuse. Viewed in the light of our modern practice, such attempts may appear weak and lame, but it is largely owing to those who thus struggled with very little to encourage them that we have advanced to where we are.

All honour to the late Mr. Alfred Fryer, whose name will always be remembered in connection with the first successful attempt to destroy refuse ; also let us bear in mind other pioneers, such as Messrs. Pearce, Lupton, Thwaites, Wilkinson, Pickard, Healey, and many others, who received little encouragement and, some of them, at any rate, even less profit.

The evolution of the destructor has been very extraordinary, but we must not think finality has been reached. One direction in which improvement is likely to be effected, I think, is in ensuring an easier maintenance of high temperature, so as to confine fluctuations within the narrowest possible limits. The effect of this will be at once obvious; nuisance will be impossible and the value of the destructor for power production will be greatly enhanced.

In conclusion, the author hopes that this work will be found of service to a large number of Surveyors, Sanitarians, Engineers, and others who are interested in the only sanitary and economic method of disposing of Town's Refuse.

W. FRANCIS GOODRICH.

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THE ECONOMIC DISPOSAL OF TOWNS' REFUSE.

CHAPTER I.

THE EVOLUTION OF THE REFUSE DESTRUCTOR.

THE destruction of Towns' refuse by burning in a furnace was first attempted nearly thirty years ago in the north of England. The first furnaces were, as might naturally be expected, exceedingly crude, the combustion being very slow and imperfect, and not to put too fine a point upon it, the refuse was merely cooked—neither burned nor destroyed.

The refuse was simply fed on to a grate—the gases evolved passing through a connecting flue to the chimney. In those days the chimney was usually higher than at the present time, for very necessary reasons, which I shall proceed to deal with directly. The original crude furnace was not largely taken up; in the first place it had little about it to recommend its adoption, and even had it been otherwise, very little enthusiasm or interest had been awakened then, on what now is one of the foremost municipal problems of the day.

About twenty-four years since the original type of furnace was improved upon by the late Mr. Fryer, and some little progress was made, but this was not destined to succeed, and much annoyance was caused by offensive smells from the chimneys. These early types of cells, although called destructors, were, strictly speaking, nothing of the kind; the refuse was [illegible] properly destroyed, owing principally to the theory [illegible] bustion receiving inadequate attention.

To reduce refuse to innocuous clinker, and [illegible] destroy the gases generated, it is necessary [illegible] Professor Wanklyn and other authorities) th[illegible] [illegible]ess than 1250° Fahr. be maintained [illegible] attempts, this temperature wo[illegible] have been reached, far less maintained; here then we have the root of the trouble and annoyance. Many instances are on record of temperatures varying from 500° to 800° Fahr., thus a high chimney was necessary. By this means the offensive gases were discharged at some considerable height above the houses, etc., yet even then certain conditions of the wind would cause them to beat down—travel low, and cause great annoyance. Further, it would be obvious that any property on rising ground round about, would often have to put up with that odour which has been aptly termed "unlike any other perfume, either on the earth, above, or on the waters under the earth."

Thus the first attempts at burning refuse were decidedly primitive and unsuccessful; the refuse was stewed, the combustion was so slow, that only a very small quantity could be dealt with per cell per day. This state of things could not continue long: several groups of cells had been put down, complaint was general, some adjunct had to be found to prevent the fumes, which once inhaled are never forgotten.

In Bolton, residents near the destructor protested and grumbled, with the extraordinary result that the authorities decided to silence the complaints of the public by buying up the neighbouring property. Here, then, was an object lesson for other towns in similar trouble, but at the same time a rather costly way of silencing complaints only too well founded.

Mr. Chas. Jones, M.I.C.E., of Ealing, who erected the first destructor in the vicinity of London in 1883, was the first to grapple to any extent with the trouble caused by the escape of noxious fumes from destructor chimneys.

He designed, in 1885, what was known as "Jones' Fume Cremator." To describe it briefly, it was an independent furnace consisting of a reverberatory brick arch, with rings of firebricks placed in the direction of the gases travelling from the destructor cells. Ribs of firebricks projecting from the top of the arch serving to deflect the gases and direct them on to the red hot mass of fire beneath. Thus it will be seen that what should have been done by the destructor proper, was left for the fume cremator to do. However, in fairness to Mr. Jones, it must be said that to a large extent his cremator did good and useful work, and some of the early destructor makers have reason to be grateful to him.

It should be pointed out that the fuel for the cremator was usually coke breeze or coke; thus the independent fire to make up for the failure of the destructor cost money for fuel. Although progress was being made, and many complaints were silenced, by abating the nuisance from destructors by adopting Mr. Jones' Cremator, yet still in some places the smells were much too often in evidence.

As Mr. Darley of Leeds has rightly said, however, the fume cremator was only instituted as a make-shift, or "an important and very necessary patch upon a very bad coat." Certain it is that Mr. Jones himself never for one moment thought that the advent of his cremator marked finality, for he says in his excellent work on refuse destructors—in referring to his "Cremator"—"You must speak well of the bridge that carries you safely over."

The next step was on correct lines, not to improve the fume cremator, but so to alter the destructor cell that high temperatures were obtained there—in short to ensure all noxious fumes being cremated immediately they were evolved. To secure this, artificial, or forced draught was made an integral part of the cell; thus the fires were forced, combustion was materially assisted, with the inevitable result that much higher temperatures were reached. As a homely illustration of this I will instance the effect of the household bellows upon the smouldering domestic fire, only while this is but intermittent, with the destructor it was continuous, not directed at one point, but all over the fire. This is but a crude illustration, but I think it will suffice, as this chapter is mainly intended for Town Councillors, and those who may have to study the subject. It must, therefore, be necessarily presented in an elementary manner.

Some of the earlier experiments with forced draught showed that a temperature of 1400° Fahr. could be reached and maintained, thus it was found that a fume cremator was [illegible]ous.

With the advent of higher temperatures [illegible]ere becoming rare; further it was found that as [illegible]ly destroying the refuse, the high temperatu[illegible] of service for doing some useful work in the [illegible] With the low temperature cells, this had bee[illegible] a few cases, and even then the steam ra[illegible]gligible quantity.

As late as 1888, it was only claimed that a low temperature cell dealing with about five tons of refuse per day, could provide steam for six indicated horse power, as a maximum. With the forced draught cells it was seen that by reason of the greater quantity of refuse burned per cell, and the higher temperature secured, as much as 30 indicated horse power per hour could be obtained from one cell. Again, not only was more refuse burned per cell, but it was now destroyed, not cooked, and therefore the residue or clinker was hard and free from smell, and found to be useful for roadmaking and other useful purposes, whereas previously it was soft, far from innocuous, and of little good.

Progress has been somewhat slow, but it has been sure, and the modern destructors dealt with in this work are but evolved from their earlier prototypes, with all their faults. After many years of costly experimenting, after repeated failure, it must be said that now there are a few destructors to be had which give excellent results. The main and essential feature of the modern destructor is the maintenance of a very high temperature in the combustion chamber : often over 2000° Fahr., in some instances 2800° Fahr., have been reached. The maintenance of such high temperatures has naturally suggested the question as to how far the waste heat could be used for the raising of steam for various useful purposes. As to what has been accomplished in this and other directions by the various types of destructors in use all over the country, I must refer the reader to the succeeding chapters, charts and tests.

CHAPTER II.

REFUSE TIPPING.

[1] "Salus populi suprema est lex."

As over 800 Local Authorities in England and Wales alone, each with a population exceeding 2,000, still either tip their refuse or dispose of same in some other equally primitive manner, I venture to think that a few observations on the tipping of refuse will be of more than passing interest. It is strange, but only too true, that a very large number of watering-places and health-resorts in this country, many of which make most extravagant claims as to their pure and bracing atmosphere and perfect sanitary conditions, are yet without either any modern approved system of sewerage, or any sanitary means of refuse disposal.

Many of these places, nowadays, boast of electric light, and also various modern attractions to lure those in search of health, holiday and recreation. And so it is that the convalescent from our large cities, who have been living for the most part under up-to-date sanitary conditions, go to recuperate at a health-resort where the sewage is consigned to the sea and the refuse deposited on the land.

It is not my intention here to pillory places that fall under the above category, but merely to point out that a large number of such places are to be found. We live in such a sanitary age now that this state of things cannot continue. The time must surely come when, in choosing a health-resort, the choice will fall on sanitary health-resorts—where sewage is dealt with in a modern manner and refuse destroyed by [illegible] am not going to say how many health-resorts fall sh[illegible] ery reasonable standard at the present time; suffic[illegible] their number is considerable and alarming.

The casual visitor is impress[illegible] of the electric light, and the natural beauties [illegible] the place. If observant, he may be impress[illegible] our of departing sewage, loth to leave the b[illegible] xplore inland he may find a picturesque view blighted by a refuse tip. If he is wise he will not be too curious, as health is not found in such spots.

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[1] The welfare o[illegible] me law.

A writer in *Punch* must have seen some of this sewage, for, in giving his reason for declining sea-bathing, he says :—

> " But I've no taste for sewage,
> Diluted though it be ;
> And that's the kind of brewage
> Supplied us ' by the sea.' "

In the past, economy has too often been the watchword, not sanitation, and in too many instances the destruction of refuse by fire has been avoided as a luxury, quite unnecessary while any land within reasonable (or, sometimes, unreasonable) distance can be obtained for tipping. Recently, in the Isle of Wight, I noticed a quantity of refuse tipped on a field only a mile or so from Whippingham, and, as is usual, the lighter portion—filthy paper and light material—was blown into the hedges, there to rot, or blow further ; this, too, in the "garden of England," a district favoured by Royalty.

Refuse is often tipped on low-lying land, also in disused quarries and brickworks, or where excavation has taken place for other purposes. When once this land is levelled with buried filth it is sometimes known as "an eligible building site." One is often warned in this world as to the consequences of building on sand, but sand is surely healthy and safe as compared with the indescribable filth and decomposing organic matter strangely called an eligible building site.

In a series of bye-laws framed by the Local Government Board, referring to "New Buildings," will be found this model clause, having for its object the prevention of the erection of buildings on insanitary sites :—

"A person who shall erect a new building shall not construct any foundation of such building upon any site which shall have been filled up with any material impregnated with fæcal matter, or impregnated with animal or vegetable matter, or upon which any matter may have been deposited, unless and until such matter shall have been properly removed, by excavation or otherwise, from such site."

[1] Up to within a comparatively recent period it was a common practice for adventurous builders and others to excavate gravel and sand upon the site of proposed dwellings, and to allow the excavation to be filled with refuse collected from ash-bins and other sources.

Roads were also formed with layers of this material, but happily these practices, at variance with the proper observance of the laws of health, are now looked upon with great disfavour or prohibited altogether.

Surely no necessity for such a law as this exists if the tipping of refuse is not insanitary and harmful. If it is dangerous to build a house on a refuse tip, then obviously it must be dangerous to have a tip at all.

In August, 1896, at the Dublin Congress of the Royal Institute of Public Health, Mr. Edward Magennis read a paper entitled "Hidden dangers in the sites of dwelling-houses." In the course of the paper, he stated that "The houses in many of our towns, especially in our large towns and cities, are erected upon sites that are simply the hiding places of sewers, upon mounds that contains the remains of our ancestors, or locations that have been the reservoirs of all filth, decaying animal and vegetable matter, street sweepings and other most objectionable materials.

"In winter the heat of the building and the aspirating action of fires must tend to draw noxious gases in large quantities through the surface of the soil, and this engenders disease if preventive measures be not adopted. We know that amongst the many evils attributed to insanitary sites are reckoned typhoid, cholera, yellow fever, dysentry, rheumatism, and the numerous respiratory diseases so common to our climate.

"England, in 22 years of continuous war, lost 79,700 lives; in one year of cholera, one of the most preventible diseases, the death roll numbered 144,860."

Need any more be said on [illegible] f the subject? Are not the deaths now, ev [illegible] zymotic diseases, mostly preventible, only [illegible] erous? Alas! the matter is treated too [illegible] sanitary authority of towns hoard up refu [illegible] ite harmless, how can one wonder if the citizens are careless with such an example before them[1] ?

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[1] See report to the [illegible] the Medical Officer of Health, dated May 10th, 18[illegible]

One of the disgusting features in connection with refuse tipping, and one that has received scant recognition, is the daily visit to the tips of a section of the community "who toil not neither do they spin." They seem to take a delight, both in winter and in summer, in spending hours on the refuse tips, prodding it about and turning it over with a stick in search of hidden treasure. It is to be presumed that the game is found to be worth the candle, or it surely would not be so assiduously persisted in.

Now I submit that the class of people who are found on the tips are invariably those who are ill-nourished and habitually dirty : in short they are the very people to contract disease. Residing, as they usually do, in the poorer and crowded parts of the town it is only reasonable to expect that they are the very people to spread disease.

The wonder is that this matter has not received more attention from Medical Officers of Health. The warning, "Trespassers will be prosecuted," seems to be reserved for places where healthy recreation could be obtained, and, although my business takes me to many refuse tips to report on their composition, I have never yet noticed any such warning displayed, necessary as it would appear to be.

In many parts of the Kingdom public opinion has been aroused against the continued tipping of refuse, and not without cause, as will be seen by the following extracts from the Press. In the *Daily Express* (Dublin) for March 28th, 1900, will be found the report of a prosecution, the plaintiffs being the Rural District Council of South Dublin, and the defendants the Corporation.

The charge against the Corporation was for renting a field known as "Kearney's Field," Crumlin Road, for depositing refuse. Mr. Rynd, for the plaintiffs, said that the nuisance had existed for 18 months.

Dr. Byrne, Medical Officer of Health for the district, deposed

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[1] Dr. A. Mearns Fraser, Medical Officer of Health for Portsmouth, has proved by experiment that Typhoid Bacillus will exist for months in polluted soil.

Some three years ago an old and leaky barge was cruising about the
Thames from Teddington to Molesey, trying to find a shoot f
Hospital refuse. The Surveyor of Chiswick warned some own
if they accepted same he would cause all dumping to cease at

that he examined the place in April, 1899, when he found that the refuse was a decided nuisance. The smell from it was foul. He visited the place in January last and found that the refuse had been increased fourfold, though he had recommended in the preceding April that no further refuse be deposited there, and that the refuse there being so bad it would be dangerous to disturb it, and that it should be covered with burned lime.

The place was close to Dolphin's Barn, and within a hundred yards of the field there was a terrace of houses.

Dr. Quinlan deposed that he had examined the heap last Thursday. The manure heap was 20 feet deep. It consisted of ashpit refuse, the sweepings apparently of a vegetable market, an immense quantity of rotten fish, fragments of carcases of poultry, and other animals, including cats and dogs. He stirred up the heap, and the stench was indescribably awful. The centre of the heap was a seething mass of putrefactive fermentation. The proper way to get rid of the nuisance was by means of a destructor ; this would render the stuff innocuous.

There was a dairy in the neighbourhood which must be contaminated by being contiguous to the heap. People in the neighbourhood also had been warned against using a well near at hand.

A witness stated that he had seen ladies half a mile away from the place use their handkerchiefs to protect them from the smell. Sir Chas. Cameron, Medical Officer of Health, was examined for the defence, and admitted how serious the matter was by the following statement :—"Really, I think it is a nuisance, but I think it would be a very serious thing to break up that heap and remove it." Mr. Bryne made an order against the Corporation to abate the nuisance.

In the *Portsmouth Times* of February 17th, 1900, will be found a leaderette entitled "The Refuse Nuisance." The writer commences thus :—"The present method of disposing of refuse in Portsmouth has been for a long time one of the most abominable nuisances with which the inhabitants of this borough have had to contend." The North End Ratepayers' Association had been considering the question of disposal on the 18th of February, and a verbatim copy of the proceedings will be seen in the *Portsmouth Times* for the following day.

The chairman, Mr. J. H. Barstow, spoke as follows :—

"Since the dumping down system has been in vogue there had been an increase of preventible disease, which might fairly be attributed to this method of disposing of the stuff." He concluded by saying "that no other community would have borne with such a nuisance as Portsmouth people had endured."

Mr. A. W. White, J.P., said that "the duty of the Councillors was to look after the health and government of the town."

Councillor Gillett said :—"At the present time North End Ward received the greater portion of the borough refuse—indeed, it was becoming the borough dust-bin. The Medical Officer had himself admitted that the nuisance was injurious to health." Ultimately the following resolution was moved by Mr. A. W. White, and carried amid applause :—"That the meeting was of opinion that the dumping down of refuse at North End should be immediately discontinued, and that the only remedy was the erection of proper destructors." Since then no progress can be reported ; on the other hand, according to the *Hampshire Telegraph* of April 14th, a sub-committee of the Town Council have actually secured a low-lying swamp, free of charge, of sufficient extent to take seven years' tipping.

Here, again, the "economic" triumphs over the demand for sanitary disposal, but what shameful reading this all is. Here you have a borough, producing approximately 120 tons of refuse per day, deliberately disposing of the question of sanitary disposal for another seven years in this way. However, it is to be hoped that the Ratepayers' Association will agitate again and again, until such a time as health shall be considered of more consequence than so called economy.

Dr. Fraser, the Medical Officer of Health for Portsmouth, has found a notice in the borough records for 1694 to the effect that during that year the Mayor was fined 6s. 8d. for depositing refuse in front of an inn. It was an offence then in those days, and yet to this very day this borough religiously sticks to similar primitive methods of disposal for which the Mayor was fined over 200 years ago.

Is it not shameful that a town of this size has made no progress practically for two centuries? There is a touch of humour in Dr. Fraser's report where he says : "The only argument in favour of tipping is its *antiquity*."

Complaints in the provincial press are frequent, and in the future they are likely to be multiplied. The present generation, by additional educational facilities, are being brought to see the importance of sanitary progress.

It has been rightly said that "epidemics are Nature's own most efficient health officers." There are some places in this country where little is likely to be done until the lesson is driven home with terrible force by the visitation of an epidemic. Again and again has the Surveyor recommended the adoption of destructors, backed up by the opinion of the Medical Officer of Health, but there are places, unfortunately, where both of these gentlemen get very unpopular with a section of the Council at once, if their recommendations involve the spending of some money.

Some time since I heard a Councillor say : " Our surveyor is a man with very big ideas ; he is always bringing forward some large scheme, just as though he must do it to justify his occupation here." Now, with all due respect to my worthy friend, I am afraid that this is a view taken by a number of Councillors. They seem to forget that, strictly speaking, their Surveyor can only justify his occupation by a most careful regard for the public health, whether his precautionary measures are in harmony with their so-called economic views or not. There is no doubt that a great deal of the determined opposition to sanitary reform is actuated by ignorance ; it is only reasonable to suppose that on many Councils there are men who do not realise the vital importance of sanitation, mainly because they are business men who have not the time for study. If they were only able to give the matter the attention it deserves, they would not hold so fast to what they call the economic ; but at the same time it must be said that men who have not the time to properly grasp the vital importance of preserving the public health have no business on Councils at all, except that they are willing to be guided by those who properly understand the question.

Tipping has been condemned at the following, among many other places :—

WELLINGBOROUGH.—" Tips very unsatisfactory ; it was decided that a deputation visit various destructors." Result—A Mason's Gasifier ordered.

FARNWORTH.—" Tips must cease ; they spread disease." Result —A Bennett-Phythian Destructor erected.

SPALDING.—" Tipping most unsatisfactory."

Aberystwyth.—"Medical Officer of Health strongly recommended a destructor as the only satisfactory method of dealing with the refuse."

Bedford.—"Tipping condemned as a great nuisance."

Ilkley.—"Tipping objected to all round; must adopt destructors."

Worcester.—"A source of constant complaint."

Leamington.—"Very serious complaints *re* tipping."

Lowestoft.—"Serious complaints of nuisance from tipping." Result—Horsfall Destructor ordered.

Blackburn.—"Tipping complained of." Result—Destructors extended.

Heywood.—"Tipping has caused a deal of complaint here. About a year ago a large tip was on fire to the extent of a hundred cubic yards. The stewing fumes created such a nuisance that it was suggested to use a large fire-engine to pump water on the fire. It has now been decided to erect a Meldrum Destructor."

Cleckheaton.—"Refuse tipping is a nuisance."

Ossett.—"The present system of tipping refuse into quarries is a nuisance, and will have to be stopped."

Tynemouth.—"Serious complaints *re* tipping, at a Ratepayers' meeting."

Ramsgate.—"Constant complaint *re* tipping"—Result, Horsfall Destructor ordered.

Southport.—"Many complaints, but tips were used until no more could be got, then a destructor was decided upon."

Pontypridd.—"In the *Glamorganshire Free Press* of August 6th, 1898, will be found the following:—'Sweet-smelling Pontypridd.' A correspondent writes from Pontypridd complaining of that body which has charge of public sanitation and cleanliness, and is directly responsible for preserving the public health. 'The Pontypridd District Council are a wonderful body,' he writes, 'they can manufacture building land by the acre. This is invariably done close to the working man's dwelling, by gathering the rubbish of the district and depositing it there, converting the neighbourhood into a pestilential area. One of these heaps can be seen at Pantygraigwen. It is a strange medley of dead cats, decaying vegetable matter, and many other things unmentionable.

The odour arising therefrom can be better imagined than described. Recently the Council commenced tipping at Newtown, but here they take the precaution to mix lime with the refuse. It is a significant fact that the Chairman of the Council resides not far from Newtown. Why should one part of the district be treated differently to to another, and why should the refuse from the dwellings of the better class be brought from those localities, and heaped, so to speak, at the doors of the poorer section of the community? The District Council owes its duty to all classes alike.' "

"A writer on 'Disease and Death' in the *South Wales Daily News*, used the following grave words :—'Disease is and for years past has been deliberately manufactured in the colliery districts, the germs of filth—fevers like typhoid are being produced and scattered broadcast, as certainly as though they were the products of a recognised manufactory.'"

RATHMINES TOWNSHIP.—"Here there has been serious complaint of the nuisance caused by depositing refuse—animal and vegetable matter—at Kimmage, and by the burning in a large open fire of all kinds of filth."

HALIFAX.—"Tipping has been most severely condemned, with the result that a destructor will be very shortly adopted."

SHEFFIELD.—"Much indignation has been caused by the inadequate destructors provided, resulting in an immense deposit known as Bole Hills tip; naturally the people in the neighbourhood of this tip severely denounce those who cause the refuse from other districts to be brought to their vicinity."

STOCKTON.—"Carcases were buried in some fields, causing much annoyance; eventually the Authorities were compelled to exhume same at considerable cost and then to burn them. A Horsfall Destructor is now on order."

STOCKBRIDGE.—"The Earl of Wharncliffe having declined to sell any land for tipping purposes, it is recommended by the Council that a modern destructor be erected."

LEVENSHULME.—"The continued tipping is a very serious matter and most objectionable, hence the Council are considering the advisability of erecting a destructor."

KIDDERMINSTER.—"Complaints of disease caused through tipping."

DOVER.—"Tipping complained of at the village of Martin."

SCARBOROUGH.—"Much annoyance has been caused through tipping at this fashionable seaside resort. It was decided to erect a destructor, but the opposition to the sites selected was so unreasonable and determined, that no headway has been made."

COLNE.—"It was the practice here to tip the refuse and to cover same with a layer of earth four feet thick, but, notwithstanding, it was established by expert evidence that there had been a breach of the Public Health Act, and when the case came into Court the Corporation were ordered to pay all the costs of litigation. Since then a Beaman and Deas Destructor has been erected."

KIRKCUDBRIGHT.—"A very serious nuisance resulted here from tipping, and Sir Henry Littlejohn, of Edinburgh, was instructed to report upon same."

BEVERLEY.—"It was the custom here to burn pigs at the Gas Works, but the firemen, who were engaged to burn something less objectionable than diseased animals, rightly objected, with the result that the pigs went elsewhere. A destructor of the Warner type is now in hand for Beverley."

BANGOR.—"Ratepayers and visitors complained of the tipping; with the result that Messrs. Meldrum Bros., Ltd., are now erecting a destructor of the Beaman and Deas type."

HAWORTH (BRADFORD).—"Tips are a nuisance. Result—it is recommended that a two-cell destructor be erected."

WINDSOR. "The refuse tip at Dedworth was complained of, and said to be a nuisance within the meaning of the Public Health Act."

SOUTHSEA.—"An indignation meeting was held owing to the continued tipping of refuse for the convenience of a local brickmaker. In the course of the proceedings this gentleman said:—'If they destroyed the house refuse, they would destroy one of the greatest articles of commerce in the town. If the brickmakers could not get refuse, they would have to burn coal, which would add 14s. per thousand on the cost of bricks: this the builder would have to pay, with the consequence that the rents would go up.'"

SUNDERLAND.—" Serious complaints have been made *re* tipping, with the result that the Borough Surveyor was instructed to report on the initial cost and also the working cost of a destructor. The Superintendent scavenger was also directed to make enquiries with a view to securing another tip."

BELFAST.—" Thousands of tons of refuse had been tipped here, and there were serious complaints. Result—Messrs. Goddard, Massey and Warner are erecting a 12-cell destructor."

CHELMSFORD.—" Serious complaints have been made by the inhabitants of Great Baddow against the tipping of refuse into a gravel pit, close to houses, and the source of the water supply."

RHONDDA.—" The Medical Officer of Health in his report advises the abolition of tips, and the provision of a destructor."

ASHFORD.—" Complaints *re* tipping ; the Surveyor was instructed to report on the cost of a destructor."

Refuse tipping in America has also caused a deal of annoyance and it is as surely doomed there as it is here, the rapid growth of many places necessitating the carting of refuse further and further out, and is often the means of reviving a problem which many "economic" minded councillors like to forget.

Mr. Joseph B. Taylor, of Brooklyn, in his report to the Health Department of that city, in 1899, shows by a very clear reasoning that tipping is wrong, terribly wrong. It is urged that the presence of air and water in the porous soil present most favourable conditions for the propagation of bacteria ; this I think will be generally conceded. Mr. Taylor puts the process so very concisely that I think it may be of interest to quote him :—

> Where the refuse is organic in its nature considerable caution must be exercised in tipping. When organic matter breaks up under natural conditions it is now generally acknowledged that this change is accomplished by the aid of micro-organisms. For the purpose of a rough classification these organisms may be divided into ærobes and anærobes, the former having the power to take up oxygen from the air, the latter securing oxygen from the complex organic substances which are thus split up into simpler compounds by the abstraction of the oxygen.
>
> Under certain conditions, however, the micro-organisms of one class have the power to change their nature sufficiently to bring them into the other

class, as when an ærobe, being deprived of its air in its struggle for existence, acquires the power to arrest oxygen from compounds in which the oxygen is weakly held.

Again the anærobes are supposed originally to have been ærobes, the transformation having been effected by a change of environment. When a bacteriological examination is made of soil, it is found that in the superficial layer the ærobes largely predominate ; as we go deeper the ærobes decrease and the anærobes increase, until finally a layer is found containing only anærobes. When organic matter is thrown upon the surface layers of the soil, decomposition proceeds readily, air and moisture speedily propagating bacteria. The ærobic organisms seize upon the organic matter, splitting it up into simpler compounds, which are further oxidised by the air left by the organisms, the porous soil having an oxidising effect similar to that observed in spongy platinum and bone black.

Rain water serves to renew the necessary supply of moisture from time to time and washes any remaining unoxidised matter into deeper layers, where the anærobes complete the work so well begun. Thus all the organic matter is reduced to substances capable of being absorbed by plants to be again built up by the chlorophyll into complex substances.

Of course decomposition carried on by ærobic organisms will be more free from putrefactive odours than anærobic decomposition, because in the case of the former the gases liberated are at once oxidised by the air, in the presence of water, into sulphuric, carbonic, and nitric acids, etc., which combine to form salts with the various bases in the soil. With anærobic putrefactive processes the state of things is reversed, the gases being thrown off, and, under ordinary conditions being staple compounds, give rise to intensely disagreeable odours.

Surely it is asking rather too much of that willing servant the microbe to pile great heaps of organic refuse either within or just without city boundaries, to level up land for building purposes, expecting that the deposit will in some mysterious way purify itself.

What other result can be fairly expected than contaminated water supplies and an abnormal death-rate ?

M. Ami. Wagnon, Président du Conseil Administratif, Délégué a la Voirie, in his excellent brochure, entitled "The Sanitation of Towns by the Burning of Refuse," says :—

> In Geneva the refuse is carried and deposited on a piece of land, too often in close proximity to dwelling-houses. One cannot too energetically condemn the establishment and maintenance of such deposits.
>
> The practice followed in Ostend until now has been the same as in all other Belgian towns. It consists simply in leaving the refuse to putrefy after it has been buried at a certain depth, or using it for filling up holes, or else depositing it in heaps in the surrounding country.

The consequences, from a public health point of view, of this detestable practice need not be mentioned here.

The casting of refuse into the sea, which has been thought of, is a barbarous proceeding, the deplorable results of which are only too easy to foresee. At Marseilles, as well as at New York, this system has had to be abandoned. Thrown in at the entrance to the bay the refuse, carcases of animals, etc., were brought back by the currents on to the beach between Coney Island and Far Rockaway. At Nice traces of refuse could be seen along the two principal Marine promenades.

Dumping refuse at sea has been pithily expressed by an American writer as "tipping in water": it is a wretched practice, with little if anything to recommend it. Chemical change in organic matter is a very slow process in water.

From experiments made in Boston, U.S.A., it has been ascertained that heaps of refuse which had accumulated for nearly ten years still contained remains of organic matter in which decomposition still continued. Mr. William Booth Scott, engineer of the City of Boston, ascertained this fact by digging among some of the old refuse heaps.

The experiments made in Brussels by Mr. Petermann, at the Refuse Depôts of Needer Over Heembeek, have given the following results per 1,000 kilos.:—

Heap No. 1, which had been lying in Depôt 5 months, Organic Matter, 307,500
Cinders, 692,500
Heap No. 2, which had been lying in Depôt 11 months, Organic Matter, 297,500
Cinders, 702,500
Heap No. 3, which had been lying in Depôt 3 years, Organic Matter, 327,500
Cinders, 672,500
Heap No. 4, which had been lying in Depôt 9 years, Organic Matter, 266,500
Cinders, 733,500

As an average of the four heaps the organic matter consisted of:—

Nitrogen	4,470
Carbon, Hydrogen, and Oxygen	295,530

Deposits thus established become necessarily injurious to public health, because, as we have just seen, the refuse contains nearly 30 per cent. of putrescible organic matter.

Professor Marvaud, of Lyons, in his work entitled "Les Maladies du Soldat," devotes several chapters to demonstrate that typhoid fever, cholera, typhus, and dysentry, can very well be ascribed to the invisible and subtle miasma arising from refuse in a state of putrefaction.

The committees of public health for the communities of

Molenbeek and Laeken report as follows with regard to the refuse tips of the city of Brussels :—

> The refuse of Brussels deposited in heaps presents evidently inconveniences from the point of view of public health. All hygienists agree in recognising that these accumulations create inconveniences and sometimes dangers, because they are composed of putrescible matter, capable of infecting the neighbourhood, and of polluting the streams of water, especially superficial streams.

The Department of Public Health for the City of Brussels also unanimously oppose any other method than that of final disposition by fire. Much more evidence might be adduced to show that the tipping of refuse is a menace to the public health, manifestly insanitary and dangerous.

Little is likely to be done in many towns in the kingdom until the powers that be are forced to see unmistakeably that the public health must not be sacrificed for so called economic reasons. Some eminent gentlemen unfortunately worry very much more about a penny advance in the rate, than a rise of 1 per 1,000 in the death-rate.

That the tipping of refuse is responsible for zymotic disease and diarrhœa is only too well known to sanitarians. In tropical climates, of course, this trouble is aggravated : it is said by some of the most eminent European medical men in the Argentine, that the tipping of refuse in some of the large and populous cities on the South American coast largely accounts for the deadly yellow fever scourge. South American refuse, generally, is largely composed of garbage, and, as this is often dumped in hollows near the shore, the action of the salt water rapidly makes the deposit a terrible danger to the community.

It will thus be seen that serious as this trouble is at home, it is even more so abroad, particularly in tropical countries. Much yet remains to be done, even in our own British Colonies. It is rightly said that trade follows the flag, so does sanitation, but it is generally a very long time after.

As M. Ami. Wagnon has pointed out, in the Laws of Moses may be found minute instructions intended to preserve the tents of the Hebrews from offensive odours arising from putrefying substances. The Romans and Greeks also recognised fire to be the great purifier.

Is it not shameful then that here at the dawn of the twentieth century hundreds of thriving communities, even in our own country, still accumulate their waste and filth in the most primitive manner?

Tipping has been rightly styled a wretched relic of antiquity—a miserable link with the insanitary past. That it is the oldest method of disposal, no one will dispute: it was not such a serious matter in the Neolithic Age, primitive man was not gifted with a very acute nervous organisation, and the facility with which he could change his residence, gave him little reason to grumble at accumulations of filth. He could get away from the filth, but nowadays when people cannot move so easily and so frequently, when so many of our cities and towns are densely populated, the condition of matters is reversed, the filth must be once and for all removed from the people.

Tipping on land or tipping in water will not do; they do not meet the case; they are not final; they fall short even of the sanitary standard in the time of Moses. The Romans and Greeks knew better, and here in our time, in the light of our modern sanitary science, are we to agree with any method but one of final disposition? There is only one method of final disposition for the whole of the waste, that is the great purifier—fire.

CHAPTER III.

REFUSE SORTING AND UTILISATION.

JUST as refuse tipping still has strenuous advocates, so has the system of sorting and utilisation, which is in many respects closely allied to the former. If the process of sorting, screening and utilising waste is such a profitable and sanitary method of dealing with refuse as some would make believe, then is it not very remarkable that such works do not multiply all over the country?

On the other hand, when the average local authority have once made up their minds to dispose of their refuse in a final and sanitary manner, and begin to consider the available means to that end, it is very rarely indeed that sorting and utilisation schemes receive any consideration whatever. To say the least of it, this is very significant.

Mr. G. Lister Sutcliffe, in a very interesting brochure entitled "The Disposal of Refuse from the City of London," describes the sorting system at Lett's Wharf as follows:—

> The operation of sorting and sifting is the sort of work to which convicts ought to be set, as in "Utopia" all vile service, all slavery and drudgery, with all laboursome toil and base business, is done by bondsmen.

In London, however, strange to say, it is done by *women*, and stranger still this very fact, "that it finds employment for a few women," is considered by Mr. Bates, the Chief Clerk to the Commissioners, to be the only justification of the noxious process.

Many years ago the condition of these women was described by Dr. Sedgwick Saunders, the Medical Officer of Health to the City, in these graphic words:—

> When the dustcarts arrive at the wharf their contents are tipped into heaps at a place most convenient to the people who are engaged as sorters. About seventy persons, chiefly women, were engaged in this degrading and loathsome work, most of whom are paid by piecework; but female sifters received 7s. and a little coal and wood weekly. The appearance of the women is most deplorable, standing in the midst of fine dust piled up to their waists, with faces and upper extremities begrimed with black filth, and surrounded by

and breathing a foul, moist, hot air surcharged with the gaseous emanations of disintegrating organic compounds. I shall not forget visiting some of these poor creatures in a hospital, and witnessing the condition of their skins.

Although the number of women employed has been reduced and the conditions of labour somewhat improved, yet even today "these poor creatures," says Mr. Bates, "can be seen at work from morning until night surrounded with dust up to their waists, inhaling an atmosphere more or less polluted by noxious accumulations, however great may be the care observed in keeping the wharf clean."

Within five minutes of the Strand a sorting and sifting process is carried on at a wharf on the South side of the river. I recently spent half an hour there and watched the process. I could not help feeling sorry for those women who thus sort and sift the filth of those more fortunate. I also wondered how such a filthy and degrading process could have any advocates at all in the light of our modern sanitary science.

Deputations coming to London to inspect refuse destructors should not fail to visit one of these sorting yards; they will then see their fellow-creatures, much the same as described by Dr. Sedgwick Saunders, engaged in about as vile and filthy an occupation as can be conceived.

Those members of deputations who may watch the process would do well to ask themselves this question—Is this state of things worthy of our sanitary progress at the dawn of the twentieth century? Personally I have a strong opinion that the Town Councillor who visits one of these places will very quickly decide that he can support no other scheme for dealing with refuse but that of destruction by fire.

Sorting, sifting, screening and tipping are all so far alike; they are not satisfactory or sanitary, the material is not rendered innocuous, the question of final disposal is not faced—it is, in short, a policy of shuffle and dodge.

The sorting and utilisation of refuse is dealt with at some length in the Report to the London County Council by the Medical Officer and the Engineer, dated May 10th, 1893. Thus :—

> The processes carried on in a London dust contractor's yard have not undergone much alteration since the following description by Dr. Ballard was written :—
>
> On a load of dust being upset from the dustcart upon the surface of the

> yard, some men and boys proceed to sort it. They are each provided with a fork and an instrument called a "drag," which has a short handle and three cast iron teeth, set about three inches apart, and with these they fork and drag the heap over so as to separate from it obvious pieces of vegetable and animal refuse, bones, rags, paper, iron, crockery, and glass. These are distributed, some of them into heaps, others of them into baskets ; the bones are put into a bin or heap in the yard by themselves for sale to bone boilers. The rags and paper are also usually set aside for sale, the iron and old tins are always set aside for sale, and usually also the glass, while the broken crockery, brickbats, etc., are laid in a heap to be sold as material for making new roads.
>
> What is left consists of cinders, ashes, and little bits of unburnt coal, and the next process is to sift this. The sifting is performed usually by women who sit on, or close to the heap, having one or more baskets by their side and a riddle in their hands. A shovelful from the heap is shaken in the riddle, and the ashes and dust having passed through, what remains upon the riddle is examined, and bones, potatoes, bits of iron, etc., not removed by the first process are picked out and thrown each into its appropriate basket ; the cinders and coal now remaining on the riddle are thrown on a separate heap, being then technically known as "breeze."
>
> The following are the terms under which the matters of a dust heap are known technically, after they are separated from one another : "Soft core," i.e., vegetable and animal refuse ; "hard core," i.e., broken crockery, brickbats, etc., and sometimes glass, old shoes, bits of rag, etc., "breeze" and "ashes."

As the outcome of their investigation do the London County Council recommend sorting and utilisation ? Oh, no. On the other hand, they condemn the same unmistakeably, as also refuse tipping, and put forward destruction by fire as the solution of the problem. This, be it noted also, was seven years ago.

Mr. W. Harpur, M.I.C.E., in his report to Cardiff Corporation on Refuse Disposal, dated 1896, speaks very favourably of the Refuse Disposal Company's Works, Chelsea, and it would appear that at this place the bulk of the sorting is done by machinery. However, the report of Mr. Harpur also mentions a visit of the deputation to Glasgow, where only a comparatively small proportion of the refuse is burned, after undergoing a mechanical sorting process.

When visiting this city more than one deputation has been advised "*to burn as much as possible.*" This was the advice given to the Cardiff deputation.

Such advice is very significant, and its importance can scarcely be over-estimated when it is borne in mind that the advice is given by a municipality having probably the most extensive sorting and utilisation process in use anywhere in the world.

The advice given by the authorities of a city with a population of over three-quarters of a million, a city with a record for municipal enterprise second to none, is "*burn as much as possible.*" Let those who are now "wobbling" on the question of refuse disposal carefully ponder over such advice.

Of course, it will be readily seen from the foregoing that, although the sorting and utilisation of refuse falls short of the accepted sanitary standard, yet some advantage must obviously accrue from the sorting and selling of that portion which has a *market value.*

At the same time, it must not be forgotten that, with one or two exceptions, the system is carried on either by a company or a contractor. To their credit, at any rate, from the sanitary point of view, local authorities do not seem to favour the process.

Against the advantages must be set clearly the disadvantages, which I will only mention briefly, as they will be only too obvious upon reflection :—

FIRSTLY.—As a general rule the system renders much handling of the refuse necessary, the air is heavily charged with dust, and such dust is dangerous.

SECONDLY.—Danger to the public health in barging or carting away that portion which is worthless, the pollution of air and water; and be it remembered that the goal of barge and the cart is usually the tip.

THIRDLY.—The varying and uncertain value of the manufactured refuse, and as time goes on the worthless residuum has to be barged or carted further and further, at an increasing cost.

FOURTHLY.—People in the neighbourhood of refuse tips very often develop a nasty habit of objecting to the refuse tips. When these hills begin to rise and stew, then, as already pointed out, another tip has to be found or a destructor has to be erected.

While it must be admitted that the sorting system, as carried on at the Refuse Disposal Co.'s, Limited, works in Chelsea, is well organised, and hand labour as far as possible superseded by mechanical means, yet this cannot be said of some other places.

Whatever may be said in favour of the process, yet we are face to face with these facts. The refuse is not finally disposed of, the residuum is not rendered innocuous, the question of sanitary disposal is not met, it is dodged.

If those interested in the subject will only take a broad general view, I venture to think that they will see at once why so few of these works have been started in the past, and why it is impossible for many more to be installed in the future.

Sorting and utilisation has been aptly described by an American writer as "Trying to save something that isn't worth saving after it is saved."

CHAPTER IV.

THE LAW AS TO COLLECTION AND REMOVAL OF REFUSE, ITS SCOPE AND DEFINITION AS APPLIED TO THE SANITARY AUTHORITY AND THE CITIZEN.

ALTHOUGH the law does not yet provide that Sanitary Authorities shall dispose of the refuse in a refuse destructor, yet it is very clearly defined that the Sanitary Authority shall possess certain legal powers, and also that certain obligations shall devolve upon the citizen.

The surveyor and the sanitarian in this country will be quite *au fait* with the legal aspect, but as I venture to hope that this work may reach those who have to face the refuse problem in other countries than England, so I am led to think that it may be of interest, not only to endeavour to show how the problem may be solved, but to quote from the London Health Act, etc., so that at the same time those readers may see the scope and definition of the compelling force—the law.

No sanitarian, I think, can peruse the clauses which "lay down the law" without feeling that a very efficient sanitary standard was aimed at, and although the various clauses laid bare may be as the law always will be, dry as dust to some, yet there will be others who, being interested in our modern destructor practice, will like to glance at the salient points in the law relating to refuse disposal in this country.

PUBLIC HEALTH (LONDON) ACT, 1891.

Herein is defined firstly what is actually meant by the various kinds of refuse referred to :—

1.—"House refuse" means ashes, cinders, breeze, rubbish, night soil and filth, but does not include trade refuse.

2.—"Trade refuse" means the refuse of any trade, manufacture, or business, or of any building materials.

3.—"Street refuse" means dirt, rubbish, mud, road scrapings, ice, snow and filth.

4.—"Ashpit" means any ashpit, dustbin, ash tub, or other receptacle for the deposit of ashes or refuse matter.

Removal of House Refuse.[1]—It shall be the duty of every sanitary authority (*a*) to secure the due removal at proper periods of ***house refuse*** from premises, and the due cleaning out and emptying at proper period of ashpits, and of earth closets, privies, and cesspools (if any) in their district ; and the giving of sufficient notice of the times appointed for such removal, cleansing out, and emptying ; and (*b*) where the house refuse is not removed from any premises in the district at the ordinary period, or any ashpit, earth closet, privy or cesspool, in or under any building in the district, is not cleansed out or emptied at the ordinary period, and the occupier of the premises serves on the Authority a written notice requiring the removal of such refuse, or the cleaning out and emptying of the ashpit, earth closet, privy, or cesspool, as the case may be, to comply with such notice within forty-eight hours after that service, exclusive of Sundays and public holidays. If a Sanitary Authority fail without reasonable cause to comply with this section, they shall be liable to a fine not exceeding twenty pounds.

If any person in the employ of the Sanitary Authority, or of any contractor with the Sanitary Authority demands from an occupier or his servant, any fee or gratuity for removing any house refuse from any premises, he shall be liable to a fine not exceeding twenty shillings.

Sanitary Authority to Appoint Scavengers.[2]—Every Sanitary Authority shall employ a sufficient number of scavengers, or contract with any scavengers, whether a company or individuals, for the execution of the duties of the Sanitary Authority under this Act with respect to the sweeping and the cleansing of the several streets within their district; and the collection and removal of street refuse and house refuse, and the cleansing out and emptying of ashpits, earth closets, privies and cesspools.

Disposal of Refuse.[3]—All street refuse and house refuse collected by, or on behalf of, a Sanitary Authority shall be the property of that Authority, and the Authority shall have full power to sell and dispose of same for the purposes of this Act as they may think proper, and the person purchasing the same shall have full power to take, carry away, and dispose of the same for his own use, and the money arising from the sale thereof shall be applied toward the expenses of the execution of this Act.

Owners, etc., to Pay for Removal of Trade Refuse.[4]—If the Sanitary Authority are required by the owner or occupier of any premises to remove any trade refuse, that Authority shall do so, and the owner or occupier shall pay to that Authority a reasonable sum for such removal, and such sum in the case of dispute shall be settled by the order of a petty sessional court.

If any dispute or difference of opinion arises between the owner and occupier and the Sanitary Authority as to what is to be considered as trade refuse, a petty sessional court, on complaint made by either party, may by order determine whether the subject matter of dispute is or is not trade refuse and the decision of that court shall be final.

[1] 54 & 55 Vict., Chap. 66, Sec. 30.
[2] 54 & 55 Vict., Chap. 76, Sec. 31.
[3] 54 & 55 Vict., Chap. 76, Sec. 32.
[4] 54 & 55 Vict., Chap. 76, Sec. 33.

Provision on Neglect of Scavengers to Remove Dust.[1]—If the Sanitary Authority, or any persons employed by them, neglect for the space of seven days to remove all such house refuse as they are required by or in pursuance of this Act to remove, then an occupier of premises (after twenty-four hours notice given by him to the Sanitary Authority requiring them to remove the same) may without prejudice to any other proceeding under this act give away or sell his house refuse, and any person, who in pursuance to such gift or sale removes the said house refuse, shall not be liable to any fine for so doing. Save as aforesaid, if any person other than the Sanitary Authority or their contractors or servants receives, carries away, or collects any house refuse or street refuse from any premises or street, such person shall be liable to a fine not exceeding five pounds.

Removal of Filth on Requisition of Sanitary Inspector.[2]—Where it appears to a Sanitary Inspector that any accumulation of any obnoxious matter, whether manure, dung, soil, filth or other matter, ought to be removed, and it is not the duty of the Sanitary Authority to remove the same, he shall serve notice on the owner thereof or on the occupier of the premises on which it exists, requiring him to remove the same, and if the notice is not complied with within forty-eight hours from the service thereof, exclusive of Sundays and public holidays, the matter referred to shall be the property of the Sanitary Authority and be removed and disposed of by them, and the proceeds (if any) of such disposal shall be applied in payment of the expenses incurred, with reference to the matter removed, and the surplus (if any) shall be paid on demand to the former owner of the matter.

The expenses of such removal and disposal, so far as not covered by such proceeds, may be recovered by the Sanitary Authority in a summary manner from the former owner of the matter removed, or from the occupier, or, where there is no occupier, from the owner of the premises.

The model bye-laws issued by the Local Government Board, Section 44 of the Public Health Act, 1875, made provison for:—

1.—The removal of house refuse from any premises by the occupier at regular intervals suited to the locality.[3]

The occupier of any premises on which any house refuse may from time to time accumulate, shall on such days, and at such hour of the day as the Sanitary Authority shall fix and shall notify by public announcement in the district, deposit on the kerbstone, or on the outer edge of the foot-path, immediately in front of such premises, or in a conveniently accessible place on the premises as the Sanitary Authority may prescribe by written notice served upon the occupier, a moveable receptacle in which shall be placed for the purpose of removal by, or on behalf of, the Sanitary Authority, the house refuse which has accumulated on such premises since the preceding collection by, or on behalf of, the Sanitary Authority.

Bye-Laws of London County Council.—The bye-laws made by the London County Council, under Section 39 (1) of the Public

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[1] 54 & 55 Vict., Chap. 76, Sec. 34.
[2] 54 & 55 Vict., Chap. 76, Sec. 35.
[3] In London the duty devolves entirely upon the Sanitary Authority.

Health (London) Act, 1891, so far as house refuse is concerned, are also exceedingly useful, especially as regards provision of suitable ashpits, their size, that they shall be kept properly covered and the contents not exposed to rainfall.

It may be said that ample provision is made by the existing laws for ensuring an efficient sanitary standard up to a certain point. By this I mean that although certain clearly defined obligations are imposed upon both the Sanitary Authority and the citizen, yet after both the former and the latter have strictly observed the law, even then the real refuse disposal problem confronts the Sanitary Authority and the thoughtful citizen.

That material which, while it is comparatively fresh in the ashpit, is so hedged round by the law, by a strange irony can cause nuisance with impunity a little later, then the arm of the law seems rarely long enough to reach.

CHAPTER V.

THE VALUE OF TOWNS' REFUSE FOR STEAM RAISING.

TOWNS' refuse is undoubtedly a mixture of all that is filthy, deleterious and objectionable, and the very nature of the material demands burning as the only effective means of disposal. I think that the majority, if not all, of those who have to deal in any way with the disposal of refuse will be quite agreed upon this point. Modern destructor practice serves to show that while refuse can be thoroughly destroyed the high temperature gases of combustion are of much value for the raising of steam. There can be no doubt that for the most part all over the Kingdom towns' refuse contains much that is of real value for the raising of steam.

It should be quite unnecessary to labour this point to any great extent ; it is now generally admitted even by those who in the past have been antagonistic that refuse has a market value. Of course, the value must necessarily be varying, according to the district, the class of population, the proximity to coal fields, and other reasons, but still that refuse has a value as fuel is proved, certain, and beyond dispute.

This has not been demonstrated by one type of destructor only, the tests have not been of "the hole and corner variety," and under certain artificial and favourable conditions. Neither has the refuse been carefully selected and sorted : had this been the case some reasonable excuse for hesitation and scepticism might exist. On the other hand, it has been clearly proved by excellent results, obtained in various parts of the country, under a variety of conditions, in some cases favourable, in others quite the reverse, that towns' refuse is a valuable asset. Of course, it is needless to add that there is a wide and certain difference in the value of refuse in different districts. But where coal is cheap, in and round about our coal-fields, I think I may safely say that within 50 to 70 miles of coal-fields specially good refuse is available for very obvious reasons, which I will endeavour to show.

Where coal is to be purchased cheaply, generally speaking, it is not carefully burned, and a very good proportion of partially consumed coal, with good cinders and ashes, are thrown away; also in cities and towns far removed from coal-producing districts a certain waste is always going on. Where servants burn coal which the master pays for, a good proportion is very often wasted. Again, in most towns there is a good residential district, varying in its area, of course, but here the refuse will naturally be much better in quality than in the poorer parts of the town, largely due to waste. The same in the inland and seaside health-resorts all over the country, where the residents do not feel the pinch of poverty and the high price of fuel, a definite waste is always going on. Thus, very often, although the coal may have to come a long way from where it is mined, yet by reason of waste the refuse will compare very favourably with centres of an artisan class where coal can be had for a few shillings per ton. From what I have seen I am led to think that the poorest of refuse is found in rural districts where the population is largely made up of the agricultural class; in such places, except that they be in or near coal field areas, little coal is used, wood being the staple fuel.

In many of the sparsely populated towns of the south, far away from coal districts, where the population is more of the artisan class, I have often found a marked absence of cinder in the refuse. Very often, also, in such towns the tips are largely composed of trade refuse, often of a very light character and of little value for steam raising, yet it is very necessary that this should be destroyed.

Recently I had occasion to visit a town with a population of about 8,000. In this instance the inhabitants are mostly of the artisan class, and the nearest coal-field is about 100 miles distant. In normal times the cheapest coal available in the town is about 17s. per ton. Here I had an opportunity of carefully examining the refuse as it lay on the tips just outside the town. I was quite convinced from what I saw that one pound of their refuse would evaporate 1½ lbs. of water—that is, it was equal in steam-raising power to 20 per cent. of the value of their cheapest coal; to go further, and put a figure on it, the refuse, as compared with the coal, was worth 3s. 3d. per ton.

Now this town is, comparatively speaking, a poor town; it is one of the decaying industrial centres of East Anglia, yet here, in a place which at first sight would appear to be the reverse of promising, refuse is worth 3s. 3d. per ton. This is not an isolated case, neither is it a specially selected one. But let us now take a town which is in the heart of a coal-producing district—the town of Darwen, in Lancashire. Here the Town Council estimate themselves that their refuse has 20 per cent. of the calorific value of their coal, and, be it noted, coal is cheap here ; yet they tell us that five tons of their refuse is of equal value for the raising of steam to one ton of the local coal.

I could multiply such cases, but it is unnecessary ; it will be very evident from the figures of tests here published that in many cases refuse has a remarkable value. It is significant to compare the figures obtained by different destructors located in towns situated in coal areas, for instance such towns as Oldham, Rochdale, Darwen and Warrington. I think if the evaporation per pound of refuse in the above-mentioned towns is compared, it will be at once apparent that even where coal is cheapest the refuse is remarkably uniform and of good calorific value.

It has been urged by many that refuse has no calorific value worth speaking of—that it possesses really no potential energy beyond the heat necessary for its own incineration. It is urged that because refuse smoulders on the tips in some places instead of burning briskly, and because it has been found impossible to burn it at all satisfactorily in some crude, improperly-designed furnaces, then it is necessarily worthless.

The weakness of such a line of argument will be very apparent to anyone with the slightest knowledge of combustion. It might as well be argued that because coal-dust or coke-dust cannot be successfully employed for the raising of steam with the ordinary furnace and draught, then such fuels are useless.

Just as it is a question of adaptation with low grade bituminous fuels, so it is with waste products and refuse. That this is perfectly correct and logical is proved by the fact that such a product as pressed sludge can be successfully burned in cells adapted for that purpose.

Although the tables accompanying these remarks are very significant indeed, yet it must not be forgotten that ten years ago, or, say twenty years ago, when refuse was not even decently burned, to say nothing of being burned to advantage for power generation, even then refuse was quite equal, or richer, in calorific value to what it is to-day. It is useless, therefore, to urge that a change in refuse has brought about such a change in the performances of destructors.

No, the change has not been with the material but with the appliance, and that material which in the early days of destructors could scarcely be made to burn satisfactorily, is to-day burned at a high rate of combustion with a high temperature, without nuisance and in such a manner that an immense amount of power is available for useful purposes.

Less than twenty years ago destructors were adopted solely to get rid of refuse. If it could only be got out of the way, without nuisance, the plant was considered satisfactory. Contrast this with the position to-day, and what do we find? Simply this—that almost invariably every destructor erected now is decided upon with some other definite object in view besides destruction pure and simple.

In these days the refuse destructor is boldly associated with electric lighting of towns and districts, sewage pumping, water pumping, and other useful power purposes. Why? There is only one answer, and that is because it is now generally recognised that refuse is a valuable asset, that it possesses a calorific value. Now this has come to be recognised, Authorities are not content to put the useful heat developed up the chimney; those days have passed. I ask those who still doubt the value of refuse as a fuel to look carefully into the record of contracts for destructors placed during the past year; they will find that the vast majority have been placed with makers of destructors which not only thoroughly destroy refuse, but raise a large quantity of steam therefrom. It will thus be seen that destruction alone does not satisfy.

Personally, I am exceedingly suspicious of the non-steam-raising destructor, and I am rather suspicious of the destructor which only raises a little steam, my reason being that if refuse is burned rapidly and thoroughly at a high temperature of combustion in a well-designed plant, then good steaming results are inevitable.

On the other hand, if refuse is being burned at a low temperature of combustion, and little or no steam is being raised, such sequence is but natural. Undoubtedly the best steam-raising plants are those where the highest temperatures are maintained; then also there can be no doubt as to their value as perfect destructors. On the other hand, the poorest steam-raising plants are those with the lowest temperatures, and it is scarcely necessary to add that nuisance always proceeds from low temperatures.

In the many complete tests here published it will be found easy to compare temperatures and work done; all go to prove that refuse is of value for the raising of steam.

AVERAGE COMPOSITION OF ASHBIN REFUSE (HUTTON).

	Percentage of weight.
Breeze and cinder	50·0
Paper, straw, fibrous material, and vegetable refuse ...	13·0
Coal	·7
Bones and offal	·6
Rags	·4
Coke	·3
Ash	12·0
Dust and dirt	20·0
Bottles 1 %, tins ·7 %, metals ·2 %, crockery ·6 %, broken glass ·5 %; a total of	3·0
	100·0

HEATING POWER OF ASHPIT REFUSE (DAWSON).

The average heating power of the combustible portion of the refuse is as under :—

	Calorific value, or units of heat developed per pound of combustible.	
	When dry.	When containing the average percentage of moisture.
Coal	14,000 ...	9,334
Coke	12,000 ...	8,000
Bones and offal...	8,000 ...	5,334
Breeze and cinder	6,000 ...	4,000
Rags	5,000 ...	3,334
Paper, straw, fibrous material and vegetable refuse	3,800 ...	2,534

AVERAGE EVAPORATIVE POWER OF TOWNS' REFUSE OBTAINED IN PRACTICE (HUTTON).

Description :—	Weight of water evaporated from and at 212° Fahr. per pound of refuse fuel in pounds.
Screened ashpit refuse, the best	2·00
„ „ „ averages	1·50
Unscreened „ „ the best	1·25
„ „ „ averages	1·00
„ „ „ of inferior quality seldom exceeds	·75
Unscreened ashpit refuse, two parts mixed with street sweepings, one part by weight	·75
Unscreened ashpit refuse, two parts mixed with street sludge, one part by weight	·50

Refuse described in above table yields on the average from 25 % to 35 % of clinker and ash.

ANALYSIS OF WELL-KNOWN COALS USED FOR HOUSEHOLD PURPOSES.

	Carbon.	Hydrogen.	Oxygen and Nitrogen.
Dudley, Staffordshire	79·7	5·4	14·7
Wolverhampton, Staffordshire	79·9	5·2	14·9
St. Helens, Lancashire	79·9	5·5	14·6
Haigh Moor, Yorkshire	80·5	5·5	14·0
Hartley, Northumberland	80·7	4·8	14·5
Low Moor, Yorkshire	85·7	5·4	8·9
Newport, Monmouth	86·3	5·3	8·4
Risca, South Wales	86·8	5·4	7·8
Wigan, Lancashire	87·3	5·5	7·2
Newcastle, Northumberland	87·9	5·3	6·8
Anthracite, South Wales	93·5	3·4	3·1

CHEMICAL COMPOSITION OF VARIOUS COAL (PRACTICAL ENGINEER).

	Lancashire.	Newcastle.	Welsh.	Scotch.
Carbon per cent	80·70	83·60	86·26	78·50
Hydrogen „	5·50	5·28	4·66	8·33
Oxygen „	8·48	4·65	2·60	8·33
Nitrogen „	1·12	1·22	1·45	1·14
Sulphur „	1·50	1·25	1·77	1·45
Ash „	2·70	4·00	3·26	4·00

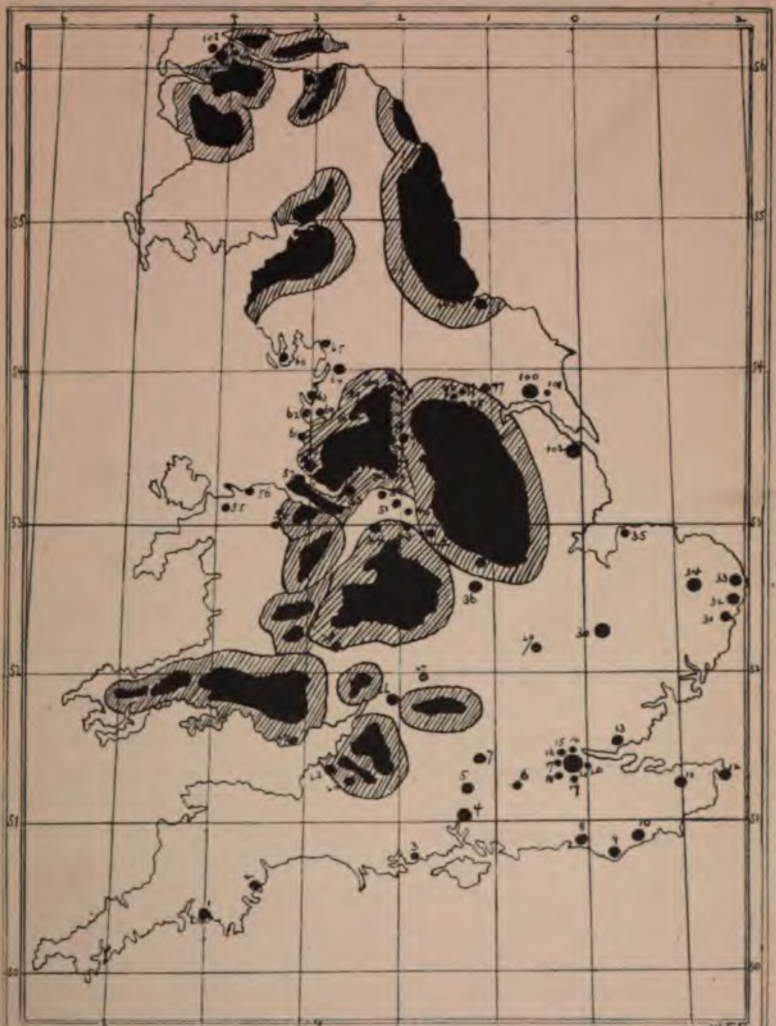

FIG. 1.—CHART SHOWING THE BRITISH COALFIELDS, THE AREAS WITHIN WHICH SPECIALLY GOOD REFUSE IS LIKELY TO BE FOUND.

RELATIVE EFFICIENCY OF COALS (PRACTICAL ENGINEER).

The accompanying table shows the composition of high and low quality coals :—

	High Quality Coals.			Low Quality Coals.		
	Anthracite.	Semi Bituminous.	Bituminous.	Anthracite.	Semi-Bituminous.	Bituminous.
Water	1·00	1·00	1·00	2·00	3·00	4·00
Volatile matter ...	5·00	18·00	40·00	5·00	15·00	34·00
Fixed carbon ...	88·50	75·50	53·50	75·00	67·00	46·50
Sulphur	·50	·50	·50	2·00	3·00	3·50
Ash	5·00	5·00	5·00	16·00	12·00	12·00
	100·00	100·00	100·00	100·00	100·00	100·00

COMPOSITION OF COAL ASH.

Description of Coal.	Silica.	Alumina and Oxide of Iron	Lime.	Magnesia.	Sulphuric Acid.	Phosphoric Acid.	Total percentage.
Anthracite ...	44·7	48·87	2·96	·58	2·00	·62	99·73
Welsh coal ...	52·2	36·30	3·86	2·27	4·55	·78	99·94
Newcastle coal ...	60·4	26·64	3·25	1·67	7·00	·84	99·80
Lancashire coal ...	48·7	35·56	6·34	1·54	6·83	·69	99·66
Derbyshire coal ...	42·5	40·00	7·87	1·37	7·46	·76	99·96
Staffordshire coal	56·4	26·61	6·37	1·76	7·91	·87	99·92
Yorkshire coal ...	62·0	20·40	5·73	2·18	8·40	·89	99·60
Scotch coal ...	54·5	29·38	8·94	1·87	4·26	·85	99·80
Lignite	20·1	18·42	22·10	2·48	33·00	3·84	99·94

CHAPTER VI.

SLOW VERSUS RAPID COMBUSTION.

It is not my purpose in this book to recommend one type of destructor in preference to another, and any invidious comparisons I desire to avoid. If comparative figures are presented as clearly and as accurately as possible, it must be left to the reader to form an opinion and make the choice. It is, therefore, sufficient if I point out that the wide difference between the quantities consumed per 24 hours in the old low temperature cells and the modern high temperature cells is very marked.

Mr. Nisbet Blair, of St. Pancras, recently pointed out, during the discussion on Mr. Newton Russell's paper read before the Institution of Civil Engineers, that the quantity of refuse which each cell is capable of destroying per day is a matter of great importance. This, I think, will be generally conceded. It must be a very important matter in London and other populous centres, where land centrally and conveniently situated is very expensive to purchase. But, while being in perfect agreement with Mr. Nisbet Blair, I am inclined to go a little further, and say that figures show that, generally speaking, the particular destructors which are dealing with the greatest quantities per cell per day are also those which are giving the highest all-round results.

Of course it has to be borne in mind that the cells of different makers vary in grate area to some extent; thus, in some instances, a cell of one type may occupy more ground space than the cell of another maker. Yet we are brought to this fact—that it is possible to burn as much as 55 or 60 lbs. of refuse per square foot of grate per hour, with an exceedingly high temperature of combustion, and very little excess of air over the theoretical quantity. Recently with a Beaman and Deas Destructor, at St. Helens, 103 lbs. per square foot of grate per hour was burned with a very good efficiency.

If careful comparison be made of the complete tests of the various types of destructors in use, which are dealing unscreened towns' refuse only, I think the reader will see at once that the advantage lays with the modern destructor.

Generally speaking, where the greatest quantity is being consumed per cell per day, there also each pound of refuse is giving the highest efficiency, and also the temperature is the highest. Further, it will be instructive to notice the connecting link all through ; the steam pressure is highest and steadiest, and the maximum in indicated horse power is being obtained from the refuse. I am well aware that this upsets some prevalent theories, but I can only refer the reader to the figures, which certainly point clearly in the direction named.

Some of the disciples of the old system of low temperature natural draught cells claim that the modern destructor sacrifices everything for steam-raising. It is difficult to understand this contention, because a destructor is only proportionately valuable as a steam raiser inasmuch as the temperature maintained is proportionately high. With a high temperature the refuse must inevitably be perfectly destroyed ; once that is done, surely nothing is being sacrificed if every available heat unit is put to the most efficient use.

I think the real explanation and origin of this charge will be found in the fact that some years since one maker, at any rate, was so very anxious to prove that an abnormal quantity of steam could be obtained from refuse that the boilers were placed immediately over the cells. Of course the result was that, with the large cooling surface immediately above the fire, the temperature was reduced, plenty of steam was being got, but the primary object of the destructor was thwarted.

The rising gases coming into contact with the comparatively cool surface of the boiler were reduced in temperature considerably, the organic matter was not burned, and the annoyance was constant. Such an arrangement of boilers and cells is now held to be most faulty in principle, and I think it may be safely relied upon that we shall not get any more steam raising of that character.

It is really a pity, in a sense, that this ever happened. It is undoubtedly responsible for much of the disbelief and hesitation which still exists. But still, on the other hand, such experiments have led on to others, and the happy medium has been struck. It is now quite possible, by having a boiler in the proper place, to raise a large volume of steam after the cells have fulfilled their primary object.

In one case, at least, one of Mr. Jones' fume cremators was used to intercept and destroy low temperature gases which had been thus reduced in temperature by such an attempt at steam raising as I have described above. Now the use of the cremator was tantamount to an admission that the principle was wrong—that the gases would otherwise escape at such a low temperature and in such condition as to be objectionable. Mr. Jones' cremator was a valuable adjunct to the old low temperature cells, and it is almost impossible to imagine how much annoyance and litigation was averted by the extensive adoption of same in the early days of refuse burning.

But Mr. Jones, like all true reformers, would, I think, admit that in these days of high temperatures his cremator is quite superfluous. I understand that recently he has been experimenting with some high temperature cells at Ealing.

In the following table is shown the quantities being dealt with per cell per 24 hours in a large number of installations with various types of destructors.

It has been urged again and again by some of the advocates of the low temperature cells that, with modern cells using artificial draught, an immense quantity of air over and above the theoretical requirements is supplied. This is a delusion, and I am inclined to think that it can only have originated through ignorance. Artificial draught has made immense strides in this country, and also in America; it is by no means confined to destructor cells, and it is quite certain that it has come to stay. Those who have advocated the use of same have been fully alive to the importance of ensuring the proper air supply to suit the individual case. Of course there are crude, wasteful, and very inefficient systems of artificial draught, but the onus is on the buyer to see that he gets the best.

With the old low temperature cells it would appear that very rarely, if ever, were the gases of combustion analysed, so that we are to some extent in the dark as to what percentage of CO_2 was obtained.

From various experiments that I have made with other natural draught furnaces, I am quite convinced that, as a general rule, the percentage of CO_2 is very low. I have seen the percentage as low as 4 per cent., and never very much over 6 or 7 per cent., and it will be obvious to those who have studied the subject that the system of working the old type of cells would most certainly tend to prevent any high figure being obtained.

It would be well to pause for a moment and see what 4 per cent., 6 per cent., or 7 per cent. of CO_2 really indicate in excess of air over the theoretical requirements. Four per cent. of CO_2 in the flue gases means nothing more nor less than that 4·7 times the theoretical quantity of air is being supplied. Six per cent. of CO_2—that you have 3·2 times what is theoretically correct, and 7 per cent. the theoretical quantity multiplied by 2·7.

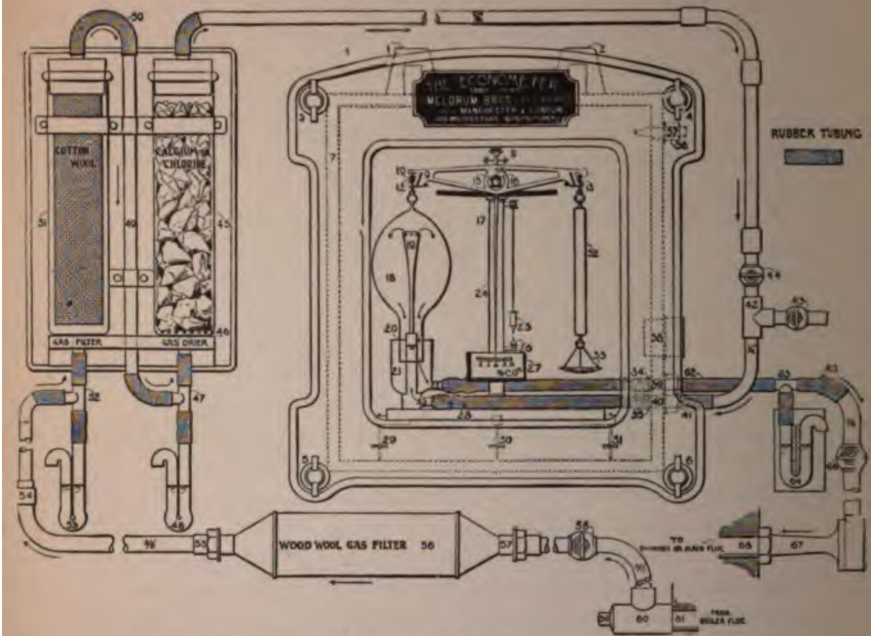

FIG. 2.—THE "ECONOMETER" FOR TAKING A CONTINUOUS RECORD OF PERCENTAGE OF CO_2 IN GASES OF COMBUSTION.

Now I will proceed to show that, with artificial or forced draught, we get very different results by analysis.

We will first take such an installation as Oldham. Here, in the tests undertaken by Lord Kelvin and Professor Barr—the latter took five samples of the gases—they were analysed by the City analysts of Glasgow with the following results :—

Samples	A	B	C	1	2
	8·60%	15·50%	18·10%	8.50%	13.30%

The quantity of refuse consumed here is 8 tons per cell per 24 hours. We will now look at another case, Rochdale, where nearly one ton per cell per hour is burned. What do we find ?

Mr. Stenhouse, the Borough Analyst, reports that "the combustion is almost perfect," and that his analysis gave the following remarkable figures—20 per cent. of CO_2. I mention this case mainly because of the very high rate of combustion.

The composition of the gases is really such a very important matter that it is indeed surprising to find it does not receive much more attention. I would point out that what prominence this question has gained is entirely owing to the use of artificial draught ; the use of same could only be encouraged when it was conclusively proved that the analysis was far in advance of natural draught results.

A very simple and correct apparatus is to be had for constantly and automatically indicating the percentage of CO_2 in the gases ; an illustration of same is here shown. (Fig. 2.) Other apparatus for the same purpose can be had, such as the "Buntes Burette" and the "Orsat" apparatus, but they are of a chemical nature, and more complicated. The "Econometer" is easily within the grasp of the fireman, and that is everything.

COMPARATIVE QUANTITIES DESTROYED BY SLOW, AND RAPID COMBUSTION DESTRUCTORS.

Town.	Quantity dealt with per cell per 24 hrs. Tons.	Type of Destructor.
Bath	5	Warner
Batley	3·5	Fryer
Birkenhead	7	Warner and Fryer
Birmingham	6	Fryer

Town.	Quantity dealt with per cell per 24 hrs. Tons.	Type of Destructor.
Blackburn	6	Fryer
Blackpool	8½	Fryer
Bolton	6	Fryer
Bournemouth	4½	Warner
Bradford	6½	Horsfall
Bristol	7¼	Fryer
Burnley	15	Beaman and Deas
Burslem	6	Fryer
Burton	8½	Fryer
Bury	6½	Warner
Cheltenham	4 to 5	Fryer
Darwen	20	Meldrum
Dewsbury	15	Beaman and Deas
Eastbourne	5	Fryer
Hereford	20	Meldrum
Hornsey	7	Warner
Huddersfield	6	Fryer
Hull	6	Fryer
Hyde	5½	Warner
Leyton	15	Beaman and Deas
Leeds	5½	Fryer
Leicester	6	Fryer
[1]Liverpool	7½	Fryer
Longton	6½	Warner and Fryer
Manchester	7	Whiley
Newcastle-on-Tyne	7	Warner and Fryer
Oldham	8	Horsfall
Preston	6	Fryer
Rochdale	23	Meldrum
Rotherham	6	Meldrum
Salford	8	Own design
Stafford	8	Fryer
Torquay	8	Warner
Warrington	15	Beaman and Deas
Southampton	10	Fryer
Shoreditch	10	Fryer
[2]Ealing	4·5	Fryer
Bradford	10	Horsfall (later installation)
Rotherhithe	18	Beaman and Deas
Hamburg	6	Horstall
Canterbury	18	Beaman and Deas
St. Helens	15	Beaman and Deas

[1] Earlier Installation.
[2] Sewage and Refuse.

[1]STALACTITE FORMATION FROM CROWN ARCHES AND BRICKWORK OF HIGH TEMPERATURE CELLS.

ANALYSIS BY MR. J. CARTER BELL.

	Per cent.
Silica	55·364
Oxides of iron	15·711
Alumina	11·362
Lime	5·390
Magnesia, potash, soda, etc.	6·173

[1] This curious formation is a most efficient natural preservative for brickwork. It will be noticed hanging from the crown of all high temperature cells and accumulates very rapidly, but is easily broken away without injuring the brickwork.

CHAPTER VII.

THE COMPARATIVE EFFICIENCY OF VARIOUS TYPES OF STEAM BOILERS FOR DESTRUCTOR AND POWER PLANTS.

SEEING that the steam boiler is now recognised as a very important part of a destructor installation, it may be well to briefly review what has been done by various types of boilers in some of the modern installations. To save any misapprehension, I will at once say that primarily I look upon the destructor as having been intended and erected to destroy the refuse thoroughly, and without nuisance of any kind. If this can be accomplished then the raising of steam is most welcome, but not otherwise. I mention this to make my position perfectly clear. I am an advocate of destructor and power plants, but only in that order, *firstly*, to destroy, *secondly*, to generate power.

It can fairly be said that with most modern destructors the refuse is destroyed without nuisance, but at the same time it will be noticed that there is a vast difference between the performance of the various destructors in their secondary function, that of steam raising. It is not my business in this work to advance theories to account for this disparity, but as every destructor maker in these days has to include a boiler or boilers of some type in connection with a destructor, I think it will be worth while to notice what work is being done with various types of boilers.

For the cremation of refuse some eminent authorities have submitted that a temperature of 1250° Fahr. is sufficient, if for purposes of argument we call that the "safety point," then if the temperature is only maintained just sufficiently high to avoid nuisance, it is obvious that such a temperature cannot be as serviceable for steam raising purposes as temperatures of 1800° to 2000° Fahr., and thus it will be seen that those particular destructors which are most efficient as destructors, must necessarily be most efficient as steam raisers. If the figures of the several tests here shown are compared, it will be at once apparent that where the highest temperature is being maintained, there also is the evaporation greatest, the steam pressure highest and steadiest, with the maximum indicated horse power available.

Thus it follows in natural sequence that where the refuse is being most thoroughly destroyed at high temperatures of combustion, a large quantity of power must inevitably be produced, I say inevitably advisedly, because if the design of the cells is correct, power must as surely follow destruction, as night follows day.

In showing the comparative results obtained with the various types of boilers now in use, it is interesting, I think, to note what the steam generated is being used for. Take, for instance, the very wide difference between driving mortar mills and high pressure engines for electric lighting of a town. A somewhat varying steam pressure would not come amiss with a mortar mill, no steam at all could be forgiven occasionally, but, needless to say, with electric lighting steady steaming is essential, and here to a large extent is explained the antipathy of electrical engineers to combined destructor and electric lighting plants in the past, the steam pressure has fluctuated to such an extent that the electrical profession have been quite justified in looking askance at the destructor, and shirking the alliance or combination.

For many years the Multitubular Boiler held the field in refuse destructor work, and a large number have been adopted all over the country ; since the advent of the high temperature destructor this type of boiler has not been much taken up. With the old type of cell where little steam could be raised it was a suitable boiler ; it answered the purpose very well, and it had the additional merit of being cheap.

For comparative purposes we will take two examples of the Multitubular Boiler—Hammerton Street, Bradford, and a more recent installation, Torquay.

BRADFORD.—Here are two Multitubular Boilers, each 11 ft. × 8 ft., which supply steam for 185 indicated horse power. In a recent test with feed water at a temperature of 50° Fahr. ·725 pounds of water per pound of refuse was evaporated.

TORQUAY.—Two Multitubular Boilers were put in here, each 12 ft. 3 in. × 3 ft., with steam drums 9 ft. × 3 ft. According to the published figures of tests made, these two boilers gave sufficient steam for 51 indicated horse power, and in the same tests the average evaporation per pound of refuse was ·334 with a feed water temperature of 50° Fahr.

The boiler of this type here illustrated is one made by Messrs. Tinkers, Ltd., of Hyde, for the Corporation of Bootle, and may be taken as representing an excellent specimen of the Multitubular type of boiler. The boiler is 14 ft. long and 10 ft. in diameter, but formed of five plates only, three shell plates and two end plates. Each ring of shell is formed of one plate, one plate forms each end, flanged at one heat by hydraulic pressure. The steam dome is 7 ft. long, formed of one plate, the diameter is 3 ft., the ends of steam chest are flanged and dished by hydraulic machinery.

The boiler contains 178 removable tubes of 4 in. diameter, as will be seen the longitudinal seams are butt jointed, with inside and outside covering straps secured with six rows of rivets. The circular seams are lap jointed and double riveted.

THE LANCASHIRE BOILER.

It is only within the last few years that the Lancashire Boiler has been used for destructor work, although for a very long time it has been a most successful type for all general purposes on land. It is not so many years ago when a pressure of 60 pounds to the square inch was considered fairly high, and when that is remembered, the evolution of the Lancashire Boiler to meet modern high pressure requirements is exceedingly interesting.

The advances made in the manufacture of mild steel as a material for boiler-making during recent years has enabled makers to build boilers of much greater power and strength than was formerly considered advisable, even if possible.

Steel Lancashire Boilers have been recently made for use with destructor cells to work at a pressure of 200 pounds to the square inch; this has only been rendered possible by the employment of the best mild steel plates and improved machinery in the construction.

The Lancashire Boiler possesses some obvious advantages over many others for destructor and power plants, its simplicity and accessibility for inspection and cleaning, the large steam and water space, enabling a considerable reserve of power to be kept—an effective thermal storage. A boiler 30 ft. long × 8 ft. in diameter will contain nearly twenty tons of water, the travelling gases are well utilised owing to the long travel.

With regard to the available water space, it is possible to have

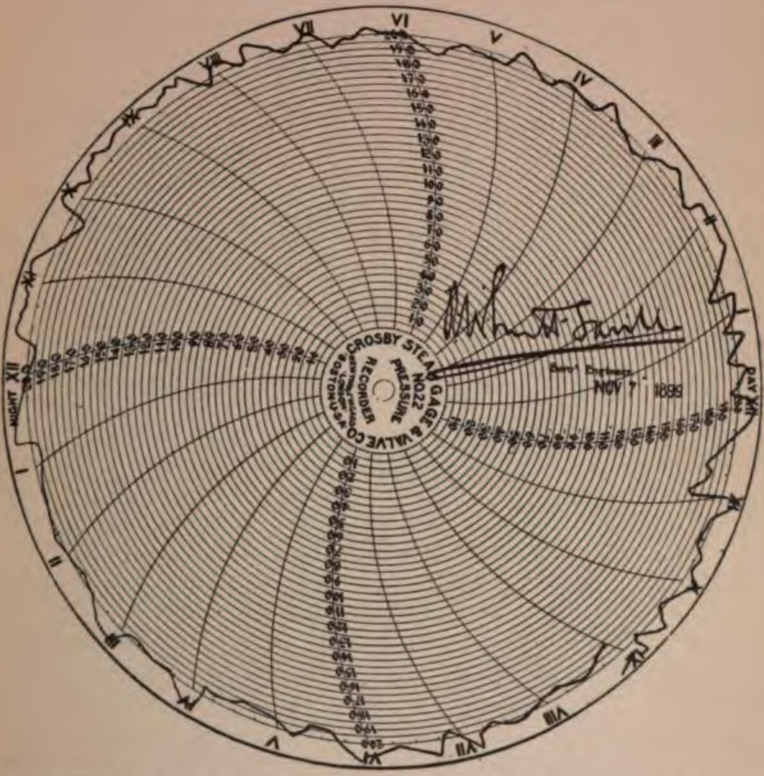

FIG. 5.—STEAM PRESSURE RECORDER CHART, TAKEN FROM THE DESTRUCTOR BOILERS AT DARWEN.

a reserve of 5000 gallons of water by feeding to the high water level when the work is light, and when the peak comes on this can be evaporated to the low water level without feeding any fresh water during the time.

As comparative examples of this type of boiler we will take the following installations.

OLDHAM, ROCHDALE, DARWEN.—Something approximating to fair comparison can be made with three towns such as these; all three are within a few miles of each other, and also all are in what may be termed a coal district. It will thus naturally follow that the refuse at all three towns will in all probability be very similar.

At Oldham two Lancashire Boilers give steam for 200 indicated horse power, and it would appear from the tests that ·945 pounds of water per pound of fuel are evaporated from feed water at a temperature of 57° Fahr.

At Rochdale two Lancashire Boilers give steam for 350 indicated horse power: 1·64 pounds of water per pound of fuel are evaporated from a feed temperature of 53° Fahr.

At Darwen one Lancashire Boiler gives steam for 250 indicated horse power (non-condensing), while from a feed temperature of 185° Fahr. 1·58 pounds of water per pound of fuel have been evaporated.

The pressure indicator chart of the Darwen Boiler (here reproduced) will show at a glance how well adapted the Lancashire Boiler is for maintaining a steady steam pressure throughout the whole 24 hours.

THE CORNISH BOILER.

This type of boiler, although very extensively used for all ordinary purposes on land, has been very little taken up for destructor work, but no doubt in the future it will be adopted in many of the smaller towns for power purposes. Like the boiler just dealt with it is now made for very high pressures. I believe I am correct in stating that Messrs. Hopkinson, of Huddersfield, the eminent valve makers, have a Cornish Boiler capable of steaming at a pressure of 400 pounds to the square inch. This, of course, is used for testing purposes, but very clearly demonstrates what is possible with the Cornish Boiler.

At Hunstanton a boiler of this type was put down last year in connection with a destructor: as this is a very unique installation, being probably the smallest town in the world provided with a destructor and power plant, it is described elsewhere. Recently,

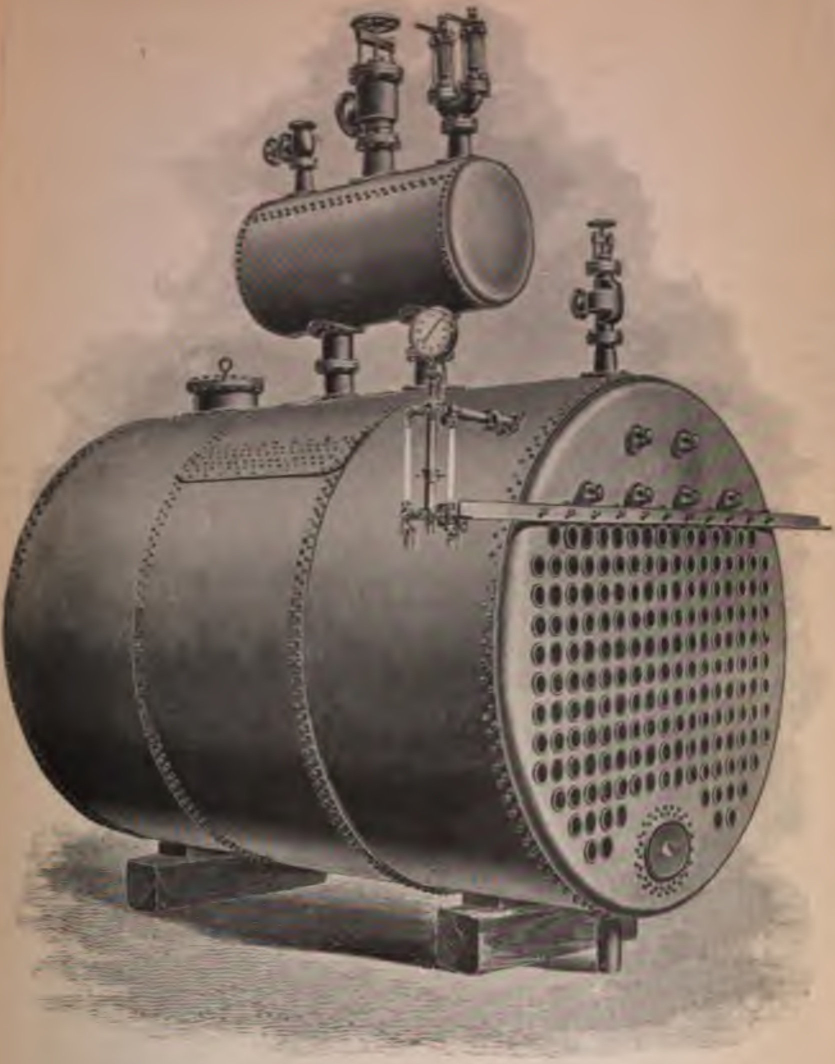

FIG. 4.—THE MULTITUBULAR BOILER—THE EARLIEST TYPE OF BOILER USED IN CONNECTION WITH DESTRUCTORS.

(To face page 48.)

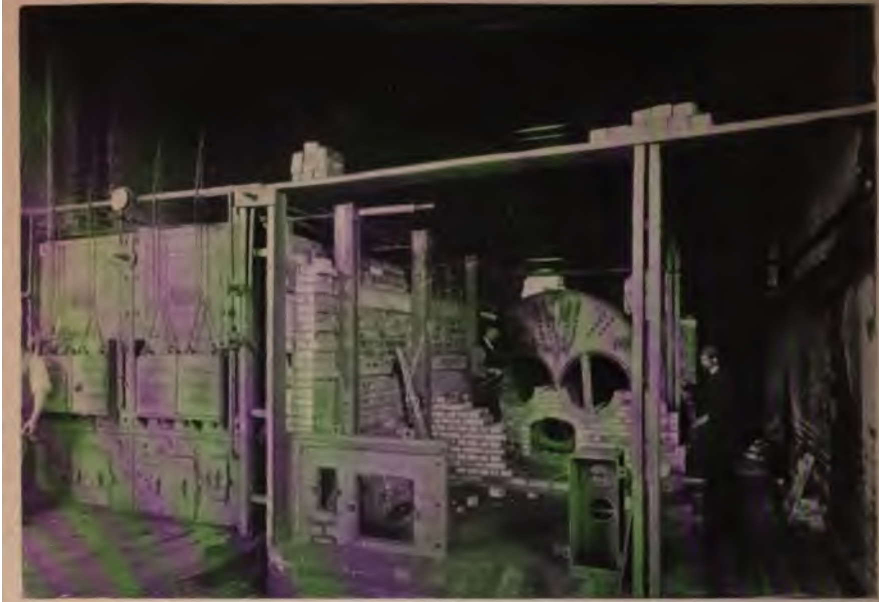

FIG. 5.—MELDRUM'S SIMPLEX DESTRUCTOR AT HEREFORD, SHOWING SECOND CELL UNDER CONSTRUCTION IN FRONT OF GALLOWAY BOILER.

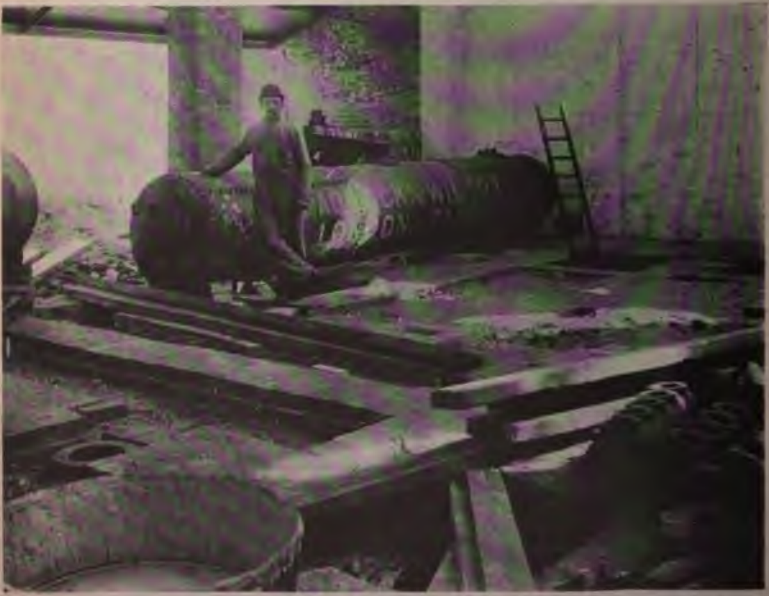

FIG. 6.—BABCOCK & WILCOX BOILER IN COURSE OF ERECTION, WITH DESTRUCTOR CELLS.

also, a Cornish Boiler has been adopted at Burton-on-Trent in connection with the destructor.

There is every reason to think that where space is not valuable the Lancashire and Cornish type are likely to be taken up in the future, but where destructors are combined with central lighting stations, and where space has to be economised, there is no doubt that the Water-Tube Boiler will also be largely adopted.

THE GALLOWAY BOILER.

It is obviously unnecessary to dwell at any length on this type; it is well known, and, so far as destructor work is concerned, for all practical purposes it can be placed in the same category as the Lancashire Boiler. A number are being used by the Manchester Corporation, and also a few at Salford, while at Hereford, also, they are used in connection with Meldrum's Simplex Destructor at the Corporation Sewage Pumping Station.

Hereford steaming results: One Galloway Boiler, 22 ft. × 6 ft. 6 in. with two flues each 2 ft. 6 in. in diameter give sufficient steam for pumping $1\frac{1}{2}$ million gallons of sewage per 10-hour day, a lift of 36 feet. With a feed temperature of 48° Fahr., the average of three tests shows an evaporation per pound of refuse of 1·39 pounds of water.

Here is reproduced a photo of the Galloway Boilers at Hereford: I am indebted to Mr. John Parker, the city surveyor, for this. (Fig. 5.)

WATER-TUBE BOILERS.

Under this head we will first take the Babcock and Wilcox type as an example. This boiler has been extensively adopted during the past three or four years in connection with high temperature destructors, and where space is limited or land valuable it is likely to be largely adopted in the future. Less space for a given power is required than for those types previously described, and in many places the Babcock and other types of water-tube boilers have been much in request because of their quick steaming qualities, but although the water tube is a rapid steam raiser, it is also a rapid steam loser, having comparatively little steam and water space.

✓Where the feed water is not of the best all water-tube boilers are a cause of much anxiety, and in the cleaning of tubes the work must be thoroughly done, and with not too long intervals. Now that greater attention is being paid to the filtration and purification of feed water, the Water-Tube Boiler is likely to be adopted to a greater extent than in the past, not only for destructor work, but for all general steaming purposes.

As examples of this type of boiler we will take Warrington and Leyton.

At the former place an average of four tests with a feed temperature of 111° Fahr. showed an evaporation per pound of refuse of 1·23 pounds of water, while one boiler of Messrs. Babcock and Wilcox's make supplies sufficient steam for 200 indicated horse power.

At the latter place the official tests showed the following evaporation, from a feed temperature of 65° Fahr. ·426 pounds of water per pound of material fired, in this instance being composed of one part of sludge to two parts of refuse. Two boilers of the Babcock and Wilcox type give steam for 90 indicated horse power.

Other types of boilers have been adopted for destructor work such as Hornsby Water Tube Boiler at St. Pancras, and also at Lambeth in connection with the plant at Phœnix Wharf there, belonging to the Clerkenwell Vestry.

The Liverpool Corporation have adopted the Stirling Water Tube Boiler recently in connection with their cells: so far as I can ascertain, this is the only place where this type has been adopted for destructor work up to the present.

✓ It will be readily seen that there are many excellent boilers on the market which, while having a splendid record for coal firing purposes, do not at all lend themselves to utilising the waste heat from destructor cells. I refer to such boilers as the Dry Back Marine type, etc. With such boilers of the fire-tube variety there must obviously be a deal of trouble with the dust choking the tubes very rapidly. With modern destructor construction such boilers would be in a position where they would get almost the first "benefit" of the suspended dust in the travelling gases.

✓ In the series of tests which are here published will be found the complete figures of a number of recent tests with various types of boilers, and in a variety of towns. These figures should be instructive if compared with the foregoing remarks.

The nature of the material to be dealt with in destructors is such that boilers of ample size should be put down, so that some reserve exists to "come and go" upon.

Trouble is often experienced in mills where coal is employed as fuel, because of the fluctuating quality. And, when short of boiler power, boilers too small for the work, and no reserve, a truck of poor coal will often bring the place to a standstill. So in much the same way with power destructors, the boilers having to depend upon a fuel which must inevitably vary with natural conditions, adequate provision should be made to ensure smooth working.

Experience has shown that it is not advisable to use boilers fired from destructor cells for supplementary coal firing as well. At Shoreditch it has been found that such a course only sacrifices the efficiency of the coal, and the inrush of cold air must also have its effect upon the gases from the cells, and thus the combination would seem to have a bad effect upon the efficiency of both the refuse and the coal, preventing full value being obtained from either. This is a very serious matter indeed, especially where Welsh coal is being used with the present high prices. One pound of Welsh coal burned under good conditions should evaporate 10 pounds of water; if by the combination only nine pounds of water per pound of coal is evaporated, it will be admitted that a sacrifice of 10 per cent. in the value of the coal constantly is just about bad enough, in fact, if a pound of refuse only evaporates one-tenth as much water as a pound of Welsh coal; then to sacrifice one-tenth of the value of the latter to burn the former under such conditions would seem to be about the height of stupidity.

If experience teaches anything, it is that, in future, boilers built in with destructor cells be only fired from that source; if additional coal-fired boilers are necessary, then let them be quite distinct; not only will this tend to efficient working, but it will also remove an ugly suspicion.

LABOUR.

As we have not yet reached that time when every man
has charge of a steam boiler must hold a certificate as

his practical knowledge, men should be chosen who are steady, sensible and methodical; men who have sufficient capacity for, and interest in, their work to weigh the philosophy of common things as they go along.

Too often are men engaged at a miserable wage to fire boilers and destructor cells, men who have had little if any previous experience at all, and so much manual labour is expected from them that it is scarcely reasonable to expect anything but muscle; brain is not paid for.

It is difficult to see why keen business men will persist in employing so much unskilled labour in the stoke-hole; it is a common practice to employ men whose knowledge of boilers and their accessories is limited in the extreme. When will it be common knowledge that throwing fuel on to a fire is not necessarily firing? It might just as well be urged that any man who can daub paint with a brush is a painter.

With a very considerable experience of firemen all over the country, I say, without any hesitation, that the majority of men who fire boilers are not firemen, and this is responsible for a large number of the smoke prosecutions.

Just as it is possible for unskilled labour to bring the mill or the factory into bad repute, so, to some extent, will the same factor at times bring the destructor into bad repute. In the same way that coal can be "murdered" or wasted, so can refuse be imperfectly burned; so can the fires be carelessly handled and the material to some extent wasted.

With the firing of destructor cells, care is necessary, and with the advent of the power destructor a good class of labour is an essential. Again and again in the past has unskilled labour been responsible for nuisance; it matters not how efficient a destructor may be, or how good the refuse is—just as with steam boilers and coal, the human element can either make or mar.

External Deposit.

Sooty deposit on the external surfaces of boilers has not, in the past, received that attention which it deserves; such deposit is a most inveterate non-conductor of heat; it may be said to be the greatest non-conductor met with.

Not only is this so, but deposit reduces heating surface, draught area, and impedes draught; thus it has to be reckoned with as a serious factor operating against efficiency and economy. The question of scale deposit on internal surfaces now receives a deal of attention, generally speaking, largely, no doubt, because its presence is a source of danger; but external deposit has not been seriously reckoned with, presumably because it lacks the element of danger.

If such deposit is opposed to efficiency and economy in the case of coal-fired boilers, how much more serious must be the matter where boilers are working with destructor cells? The deposit must, by the very nature of the material fired, be considerably more than with coal, and it has to be reckoned with as a serious factor. Therefore it is always advisable with power destructors, if at all possible, not only to put down a duplicate plant so far as cells are concerned, but also to duplicate the boilers steaming in connection therewith. When this is done, regular periodical inspection and cleaning is possible, risk of stoppage is eliminated, depreciation is reduced, efficiency and economy are conduced to.

INTERNAL DEPOSIT.

It is scarcely necessary to point out that all waters used for boiler purposes either on land or at sea are more or less impure. All the ingredients found in water are individually injurious in one shape or another to boilers, and, when in combination, are often exceedingly destructive.

Great care should be exercised in the use of compounds for counteracting the effects of substances in feed water. In the first place it may be taken for granted that such a medicine as "the universal antidote" does not exist in this connection, at any rate. Strictly speaking, the best course to adopt where the feed water is at all bad, is to employ no anti-incrustator but that one which a careful chemical analysis of the feed water has shown necessary; this is undoubtedly the safest course to adopt.

A moment's reflection will be sufficient to show that even as water differs so greatly in various districts, so must a different medicine, a different treatment, be essential; this being so, alleged universal remedies should be avoided.

A good circulation is the best preventative of scale, and, all other things being equal, the boiler with the best circulation will be found to be the most efficient all round. Some years ago I recollect visiting a large steel works in the North, where the feed water was very bad indeed, but water tube boilers were largely in evidence notwithstanding. After many careful experiments it was found that, whereas with a type with straight tubes of large diameter it was impossible to run without cleaning for a longer period than two months, it was quite possible with another type of boiler using curved tubes of small diameter, and working under identical conditions, to run for six months without a stoppage.

The simple explanation of this is, on the one hand a circulation poor and sluggish, on the other hand lively and rapid. I do not cite this instance as contending that the type of boiler last mentioned is the only perfect circulator; nothing of the kind. My desire is simply to show that in a case of notoriously bad feed water a boiler with a thoroughly good circulation resists scale formation for a long time.

The effect of internal deposit on efficiency, it need scarcely be pointed out, is a very serious matter, apart altogether from the dangerous element. It is said that one-eighth of an inch of incrustation means a sacrifice of 15 per cent. in efficiency. I have seen an appliance styled the Hotchkiss Boiler Cleaner, which certainly seems to act very effectively in the collection of floating particles of lime, mud and grease. A diagram of the arrangement here given (Fig. 7), partly in section, shows the application to a Lancashire boiler. The apparatus consists mainly of a reservoir, a funnel and three pipes; the funnel is fitted inside the boiler low enough for the edge to be just below the lowest water level, thus allowing for a good fluctuation in the feed. It is placed as nearly as possible at the back, and with the funnel pointing to the boiler front, and is connected to a pipe which passes upwards though the shell of the boiler to one of the three openings in the spherical reservoir.

The reservoir is a sphere, having three holes at top and one near bottom. These holes are for air cock, inlet, etc.; outflow pipes at top and blow-off pipe at bottom. Internally a diaphragm extends right across and half way down. This gives the current and tends to add a downward motion to the deposit. The second top opening in reservoir is fitted with pipe of the same size as that from the funnel, which passes downwards through the boiler shell to within about six inches of bottom of boiler.

To the bottom of reservoir a blow-off pipe is fitted, which can be carried to the most convenient place for the stoker. It is provided with a blow-off cock ; another cock is also fitted close to reservoir in reserve.

By filling the reservoir before lighting up, boiler circulation commences downwards in long pipe, and upwards in the pipe from the funnel, within a few minutes of starting the fires, and continues after stopping work until boiler is as cool as the surrounding atmosphere.

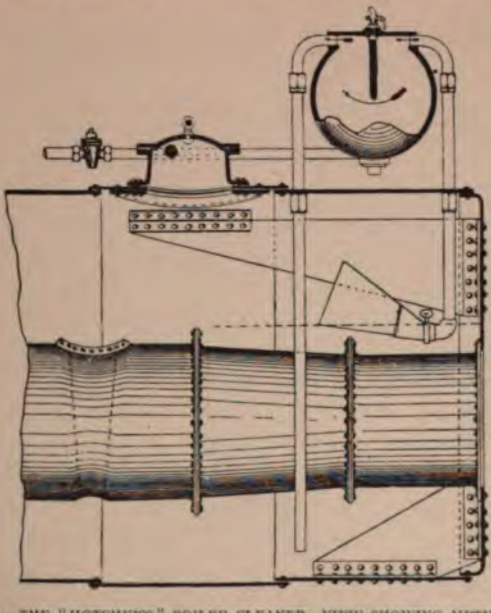

FIG. 7.—THE "HOTCHKISS" BOILER CLEANER—VIEW SHOWING METHOD OF FIXING TO A LANCASHIRE OR CORNISH BOILER.

By this means, particles of lime, mud, grease, etc., in suspension owing to the ebullition to the surface, are caught in the funnel and lifted from thence into the reservoir, where they are deposited in the quiet water by their own specific gravity, and can be blown out from time to time, usually once every one to six hours, according to the solid matter in solution in the feed water. I have often watched this blowing-out operation, and the quantity of solid matter discharged led me to think the Hotchkiss to be a meritorious invention, and for that reason I allude to it here. It is very significant that it has been largely adopted by some of the London Water Companies.

Good boiler compounds will to a large extent remove scale off the plates, or more or less prevent its formation, whereas the Hotchkiss will do more: it will collect it and eject it, and so tends to keep a boiler much cleaner; thus the element of danger is eliminated, and economy is promoted.

LANCASHIRE BOILERS FOR A WORKING PRESSURE OF 150 lbs. PER SQUARE INCH (SCOTCH MAKE).

Nominal H.P.	Length.		Diameter.		Diameter of Flues.		No. of Cross Tubes.	Weight.	
	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.		Tons.	Cwts.
30	20	0	6	0	2	3	3	11	10
35	20	0	6	0	2	6	3	12	0
35	22	0	6	0	2	6	3	13	10
40	24	0	6	0	2	6	3	14	10
45	24	0	7	6	3	0	3	15	10
45	24	0	7	0	2	9	3	16	5
48	26	0	7	0	2	9	3	17	10
50	28	0	7	0	2	9	4	18	0
60	28	0	7	6	3	0	4	19	10
70	30	0	7	6	3	0	4	21	5
70	28	0	8	0	3	2	4	23	0
80	30	0	8	0	3	2	4	24	10
100	30	0	8	6	3	5	4	27	0

CONSTRUCTION.

The boilers are made from specially selected Siemens Martin mild steel, each ring formed of one plate, the ends are in one piece and the longitudinal seams are double riveted. Rivet holes are drilled after plates are bent to form, the flues are welded longitudinally and flanged transversely at one heat. The flue flanges are turned on edge and the rivet holes are drilled by automatic machine having patent pitching apparatus. Both flanges are drilled at the same time, thus ensuring absolute accuracy.

TABLE OF SOLUBILITIES OF SCALE MAKING MINERALS (Babcock and Wilcox).

Substance.	Soluble in parts of pure water at 32° Fahr.	Soluble in parts Carbonic acid, water cold.	Soluble in parts of pure water at 212°.	Insoluble in water at
Carbonate of lime... ...	62,500	150	62,500	302° Fahr.
Sulphate of lime	500	—	460	302° Fahr.
Carbonate of magnesia ...	5,500	150	9,600	—
Phosphate of lime ...	—	1,333	—	212° Fahr.
Oxide of iron	—	—	—	212° Fahr.
Silica	—	undetermined	—	212° Fahr.

ANALYSIS OF BOILER SCALE (Chandler).

Sulphate of lime.	Magnesia.	Silica.	Peroxide of iron.	Water.	Carbonate of lime.
74·07	9·19	0·65	0·08	1·14	14·78
71·37	—	1·76	—	—	—
62·86	18·95	2·60	0·92	1·28	12·62
53·05	—	4·79	—	—	—
46·83	—	5·32	—	—	—
30·80	31·17	7·75	1·08	2·44	26·93
4·95	2·61	2·07	1·03	0·63	86·25
0·88	2·84	0·65	0·36	0·15	93·19
4·81	—	2·92	—	—	—
30·07	—	8·24	—	—	—

Steam Boilers: Their Construction and Management. With Special Reference to Destructors. By W. Bamford, Esq., Glasgow.

Paper read before the Association of Cleaning Superintendents of Great Britain, at the Annual Meeting held in the City of Glasgow, September 6th, 7th, 8th, and 9th, 1899.

A steam boiler, in an engineering sense, may be defined as a closed vessel in which steam is generated. It may assume an endless variety of forms, and be constructed of various materials. Theoretical deductions at an early period pointed to the economical advantages to be obtained by using high pressure steam, combined with an early cut-off in the cylinder or in several cylinders, and the practical difficulties of construction, then self-evident, have been successfully overcome, and the result is the marked change from the 7 to 10 pound pressure per square inch, so common sixty years ago, to the everyday pressure of 100 to 250 pound per square inch, and the use of steam of 400 to 500 pounds pressure for special purposes.

The principal difficulty in adopting higher pressure was the obtaining of reliable vessels, sufficiently strong, with moderate cost of construction and maintenance, for generating and containing the steam.

It is not here intended to give either the detailed history or growth of the steam boiler, nor yet to give a technical or learned description of the construction of the present day boiler, and the methods adopted mathematically for arriving at the strength and thickness of the various parts of the boiler to withstand the various strains and stresses to which the different parts are subjected, but rather to give some of the methods of construction and management, a knowledge of which is essential to the safe and economical employment of the steam boiler. As far as possible the data will be given in popular, rather than a technical tone, and it is intended more for the edification of those who have not had the advantage of being engineers, but it is hoped that even those who have been brought up in the engineering world will find food for thought, and be able to find some little good arise from carefully considering the items which will be presented.

Progress in boiler construction has been aided chiefly by the increasing facilities of procuring suitable materials, by improved methods of working these materials, and also by our better understanding the laws on which the safety and economy of boiler construction and management depend.

In the early days of the steam engine, vessels of copper and cast iron were used for the generation of steam. It is also recorded that structures of stone, and even of wood, with internal flues of copper and iron, were at one time employed. These, however, were probably not subject to anything higher than atmospheric pressure. In the days of the 7 to 10 pound pressure, cast-iron was found unreliable and treacherous for the boilers at that time constructed, and it was therefore discarded in favour of wrought-iron, which probably was not at first used on account of the difficulty of producing tight joints with this material.

The variety of shapes in which boilers are and have been made, and in which much ingenuity has been exercised, is due to the various duties to which they have been put, or the peculiar conditions under which they are put to work. In one case strength is required, in another durability, smallness of bulk and weight, saving in labour and material, greater extent or efficiency of heating surface, improvement in circulation, prevention of smoke, economy of fuel, facility of examination, cleaning, and repairs, etc., all exercise an influence on the design of a boiler, and it is no more possible to produce a boiler that will meet all these conditions than it is to obtain a medicine to cure all complaints, or to get a cleansing superintendent who knows absolutely everything.

An early form of steam boiler was made spherical, of cast-iron, with fire underneath. Its heating surface was small, and it was soon replaced by vessels more favourable in that respect. A cylinder with flat bottom and curved top, having encircling flues, was soon adopted. To increase its strength it was found necessary to arch it inwards. To get more surface the vertical cylinder in its turn gave way to the horizontal oblong boiler. When wrought-iron came into use the boilers were made larger, and the wagon boiler first made by Watt and so much in use in Lancashire fifty years ago was at length produced. As pressure increased it was found that in spite of elaborate staying in this boiler, its great tendency to get out of shape rendered it unfit for longer use.

With inclined sides and hemispherical top the old vertical cylinder boiler developed into the Haystack or Balloon Boiler, and was constructed of wrought-iron.

This shape enjoyed a long run in Staffordshire, and some of them were made as large as 20 feet in diameter. Then followed the egg-ended boiler with the fire beneath, and the heating surface of this was improved or extended by making an internal flue through which the hot gases passed on their way to the chimney.

To further economise fuel the fire-grate was placed in the flue, the gases afterwards passing along the sides of the boiler; this gave us the Cornish Boiler. As these boilers grew in size the internal flue became very large and subject to collapse by reason of the increasing steam pressure, and to get over this difficulty two smaller flues were then used, giving us the Lancashire Boiler.

Numerous modifications of these types are to be found. There is the Breeches flued boiler, the Multitubular, the Galloway, all of which are in regular use in one part or another. In the case of the two last named it must be remembered that the increased heating surface is obtained at a sacrifice of simplicity, and thus there is an increase in the difficulty of examination, cleaning, or repairs. The Elephant Boiler, although much used in France, never came into general favour in this country. The various forms of vertical boiler may be considered as a modified Cornish Boiler on end, and while it is wasteful in fuel, its form renders it an invaluable adjunct to many branches of industry. The Rastrick Boiler, used extensively some twenty or thirty years ago in ironworks, is a vertical boiler of large diameter with one central longitudinal flue tube, communicating with two or more horizontal flues through which the gases pass to the central tube on their way to the chimney.

The Locomotive type is much used when little space is available, and when the flat surfaces of the fire-box are properly stayed it is a very serviceable and reliable boiler for high pressures and rapid generation of steam. Some of the above boilers have circulating and heating tubes, such as Fields, etc., which add greatly to their steaming power, especially when new, and also, it must be admitted, adds to their complication.

We now come to the water-tube boiler. It is a fact that the larger the diameter of a steam boiler the greater is the power stored, other things being equal, and the greater is the explosion should the shell from any cause give way. It is also true that the smaller the parts of a boiler are, the easier it is for transport, and so to meet the case for easy transport, sectional steam boilers have been made from very early times. Although the water-tube was not extensively used in this country until some twenty years or so ago, we find that in 1774 John Blakey appears to have designed a sectional or water-tube boiler, "to generate steam of the required elasticity, and in sufficient quantity." It consisted of three rows of water pipes so inclined alternatively and connected at the ends by bent tubes that the steam formed in the boiler would rise into the upper pipes to supply the engine.

Arthur Woolf, in 1804, patented a sectional boiler consisting of a number of pipes connected to a steam drum at the top.

Goldsworthy Gurney, in 1825, patented a steam carriage with sectional boiler.

The Howard, Root, Babcock, Lane, Sinclair, Belleville, Shepherd, etc., are all members of the water-tube family, and scores of other names might be added, but probably the most popular of the water-tube class at present in use is the Babcock and Wilcox. This method of construction was introduced, I believe, by Mr. Stephen Wilcox in 1856. The boiler, briefly described, consists of a steam drum fixed horizontally over a number of water-tubes set at a considerable inclination, and connected by water headers at each end to the steam drum above. The advantages claimed are :—Thinner metal but ample strength ; better circulation ; in sections, therefore easy of transport ; easily repaired, and life prolonged indefinitely. These boilers have been largely used in sugar refineries, electric light and power works, and in general industries. It must not be thought, however, that a water-tube boiler cannot explode, for with certain conditions prevailing a very nasty accident may happen, as in the case of the Torpedo Destroyer recently, on which a water-tube boiler gave way and a number of lives were lost.

Let us now see what our boiler should be. It must be so arranged as to make the best use of the heat given off by the combustion of the fuel. It must be sufficiently strong to withstand the pressure at which it has to work, with the usual margin of safety. It should be easy of access for cleaning, and not likely to get out of repair. The work done in the boiler is to convert the water with which it is fed into steam. It may interest some to know that if water is taken at 62° Fahr. and is heated until it boils (supposing this to be done without loss of heat) 150 units of heat will have been used in the process per pound of water heated, and the temperature will be raised to 212° Fahr. If we continue to add heat so as to make the water into steam, as long as there is a free outlet for the steam, the temperature remains the same, and by the time the water has all been evaporated 966 more units of heat will have been used per pound of water to perform the evaporation, or sufficient to have raised the temperature of the water to 1178° Fahr. had the temperature continued to increase at the same rate as it did before the boiling point was reached.

If this steam could be reduced to water again without loss of heat, and with all the heat retained in it, this water should be red hot, for the temperature of 1178° Fahr. is a visibly red one. The kind of boilers with which we are mostly concerned in destructor work are the Multitubular, Lancashire, or Galloway, and the water-tube, and until six years ago no water-tube boiler was used at a destructor works, but about that time one was put in at Warrington.

We will now see how these boilers are constructed.

CONSTRUCTION.

The Multitubular Boiler.

This type of boiler consists of a wrought steel horizontal cylinder or shell, with flat end plates, both of which are bored to receive a number of lap-welded tubes, which vary in number and diameter, according to the size of the shell, or, in other words, according to the evaporation required. The length of the tubes will correspond approximately to the length of the shell. In modern practice each ring of the shell will be formed of one plate only, of oblong shape, rolled cold to bring the ends together. The type of joint used for this longitudinal seam will be either a lap joint or butt joint, and will depend upon the pressure which the boiler is intended to carry. If the seams are to be butt-jointed, a narrow plate, called a butt-strip, will be placed over the joint both inside and out, and the four rows of rivets will pass through the three thicknesses of plate. The circular seams will be lap-jointed, that is, one plate simply lapped over the other, and single or double rivetted, according to the intended working pressure.

The rivet holes throughout the boiler are drilled from the solid plate by special machinery fitted with automatic dividing appliances, after the plates are rolled into shape, no punching whatever being allowed in a good shop. The end plates will be each of one piece without joint or weld, and each end should be flanged over by a hydraulic press at one heat, so as to fit exactly inside the shell.

The holes for the tubes should also be bored from the solid plate.

The rivetting of the shell will be done by hydraulic power, as by this method the pressure upon each rivet can be regulated within a very wide range, from three tons per square inch upwards, according to the capacity of the plant; the advantage of this method being that the rivet holes are bound to be filled up by the rivet inserted if the necessary pressure is put on. All rivetting, therefore, should, wherever practicable, be done by the machine.

The building up of the boiler is commenced by bolting the longitudinal seam of the first shell ring temporarily and slinging over the rivetting machine; this having been rivetted round, another ring is added, and so on, until the length of the shell is completed, when the ends are rivetted in by hand. As the ends of the boiler are flat, it is necessary to stay them, otherwise they would bulge out with the pressure within the boiler. For this purpose some of the tubes are made slightly stronger and of thicker material than the remainder, and the ends of these have a screw thread cut upon them, and two nuts put upon each end of this stay tube, as it is called; after being placed into position, the nuts are screwed up, one inside the end plate and the other outside. To stay that part of the end plates above the tubes, tie bolts are usually employed; these are strong bolts put right through and secured in the same way as the stay tubes. Sometimes three-cornered plates, called gusset stays, are used instead of bolts, and are rivetted to the end plate and the shell by means of angle bars. Or a T iron piece may be rivetted to each end on the inside horizontally, and connected with bolt stays, each having shackle and cottar or rivets at both ends.

The ordinary tubes are usually swelled one-sixteenth of an inch larger at one end of a length of three inches than the other; this facilitates insertion, and also in the case of renewal the withdrawal of the tubes.

After being inserted into the boiler, projecting outward a little beyond each end, they are expanded by means of a roller tube expander, which expands the ends of the tubes so as to fit tightly the holes in the end plates, and thus a steam-tight joint is made. Manhole and valve bases as required are provided in approved positions, the blow-off being usually at the bottom of the back end of the shell in this class of boiler, with connecting pipe carried through the brickwork to receive the blow-off cock on its outer end. The larger boilers of this class are fitted with steam dome or receiver, either of vertical or horizontal type, so as to get the steam away as dry as possible. All plates used in boiler-making should have edges planed and corners thinned by machinery previous to bending, and after riveting, the joints should all be neatly fullered and caulked to make an absolutely tight job.

The hydraulic test to the specified pressure will now complete the job.

On account of the moderate price at which large steel plates can now be made, and their much greater strength, wrought iron is completely out of the question in boiler-making; for while some thirty years ago you would have to use four or five plates to make one ring of a boiler shell, you can now get the whole of a Lancashire boiler shell, 30 ft. long by 8 ft. diameter, in four plates, suitable for 200 lb. working pressure.

THE LANCASHIRE BOILER.

Great care is exercised in the making and testing of boiler plates for large boilers. Test strips are taken in duplicate from all plates; one is tested, and the plate stamped accordingly, and the other strip is kept in reserve. All tests are recorded, and certificates of the tests are supplied with the plates. If the inspector is satisfied with the plates, the work goes forward, but if not quite sure of the tests, further ones are made. It is understood that, as large plates are so bad to get in iron, and that steel plates, while being cheaper, are also stronger, our boiler will be a steel one. In testing, the tensile strength should be from 28 to 30 tons per square inch of section, with an elongation of 20 per cent. in a length of 10 inches.

All of the plates are planed on the edges, and the corners where necessary are thinned by machinery.

The bending of the shell plates is done in a three-roll bending machine, and they are rolled in and round until the two ends come together, and thus the complete ring for an 8 ft. boiler requiring a plate nearly 26 ft. long is made in one piece, and for 100 lb. pressure will weigh about one ton.

For 100 lb. pressure and over, butt-strips are used inside and out, and these should be cut from the plates with the grain of the strip in th direction as in the shell plates. The seams will be placed alternatel of the shell crown in building the boiler, so as not to be in a li r.

All the rivet holes are drilled on a special machine b id- ing apparatus, assuring accuracy of pitch and perf s which is very important, as in the longitudinal seam nesses of plate to deal with.

In the best type of machine four holes are drilled at either side of the shell at the same time, or eight holes all at once. All the drilling is done with the rings in the vertical position, and they are drilled in rotation in the order in which the boiler is to be built up.

The end plates having been prepared and the angles for the stays having been rivetted on by machinery, the plate being edgeways up meanwhile, we now take the back end plate and bolt a ring on to it, and with this slung in the rivetting tower over the machine, rivetting at once proceeds. As soon as one ring is rivetted on, another is attached by bolts temporarily, and proceeded with in the same way. The angle bars on the shell plates for the gusset stays are rivetted on as the work proceeds, and when the last ring is put in position the whole of the outer shell of the boiler, with the exception of the front end plate, is suspended over the rivetting machine, and it must be handled with considerable skill for the work to be done rapidly and at the same time thoroughly.

The flue plates are of the same tensile strength as the shell, but they must be "welding quality." The ends are planed to a bevel edge for the purpose of welding, which is done after heating, under the steam hammer. The edges of the flue ring are then flanged over in a flanging machine, which flanges over one end of the flue ring, in about a minute after the heating has been properly attended to. In the case of flue rings for a boiler working at 100 lb. pressure the flue rings will be approximately 3 ft. long, but for one of 200 lb. pressure they will be but 2 ft. long, the reason being to get more flanged seams into the latter to stiffen and strengthen it against collapsing under the high boiler pressure. In this method of flanging over no rivets are exposed to the action of the fire, but are all entirely on the water-side of the plates.

The flue rings are drilled and rivetted in much the same manner as with the shell; the welded seams being arranged alternately right and left and below the level of the firebars, so as to break joint. The bases and blocks are usually cast of wrought steel, and where cost is not considered, wrought steel stampings without weld are used, and make the very best job. The gusset stays (three-cornered plates) can now be put in the back end of the boiler, to be followed by the flues; then will follow the front end plate and gussets for same.

The necessary steel stand pipes or branches are provided for the fittings, which latter will consist of feed-valves, junction valve, high steam and low water safety valve, gauge taps, blow-off valve, and pendulous dead weight safety valve, together with a 10-inch dial steel tube steam gauge, figured up to twice the working pressure.

The water gauges should be fitted with self-closing valves, and the glass tubes should be covered with external shield.

Inside, the boiler should be fitted with anti-priming pipe, so as to take the steam out as dry as possible.

The necessary side dampers and frames, and flue doors and frames; the firing door to consist of cast-iron frame fitted with diamond-pattern floor plates, the centre one of which will be over the blow off valve.

The fittings, all but the safety valves, being in position, the hydraulic test is applied: that is, water is pumped into the boiler until a pressure of about

75 per cent. over the working steam pressure is reached. The water is cold, and the pressure should be kept on not less than 30 minutes, during which time the shell, flues, and fittings should be drop-dry. While this is in progress the end plates should be carefully lined so as to ascertain if there is any permanent deflection caused by the test.

The Water-Tube Boiler.

This consists of a horizontal cylinder or steam drum with dished ends flanged at the edge, made of steel plates, and connected near the front end with a series of block of headers made of cast-iron, or of pressed steel for high pressures. This may be described as an oblong box with tube openings at the top end, front and back. The holes in front are opposite the holes behind, into which the front ends of the tubes are inserted ; through the front holes access to the tubes is obtained for cleaning and inspection. When the boiler is working the front holes are closed with cast-iron lids or covers, and the holes in the top end of the box are connected by means of short tubes with the front end of the steam drum. The back end of this drum is connected by long tubes to another horizontal cylinder, which is called the mud drum, and forms the lowest part of the boiler.

The main tubes are fixed at an angle and the back ends are inserted into another block of headers similar to the front block, and also fitted with covers opposite the end of each tube. The bottom of the header is connected with short tubes to one side of the mud drum. The number, length, and diameter of tubes, the size of steam drum and mud drum, will depend on the work intended to be done by the particular boiler, but it will be seen that the size or capacity of the boiler is practically unlimited. The circulation is upward along the inclined tubes, through the front headers, backward along the steam drum, down through the back headers, and up the inclined tubes again, the mud settling into the mud drum, which is not heated.

The fire-grate is under the front end of the main tubes and the steam drum, about one-third of which is exposed to the hot gases. The course of the flame and hot gases is controlled by baffles inserted amongst the tubes ; generally it may be said that the hot gases cross the line of tubes four times (twice in an upward and twice in a downward direction). All valves and fittings are attached to the steam drum, except the blow-off valve, which is fixed on the mud drum. The general design may be described as long, high, and narrow, and consequent upon the narrowness the grate space is limited. The length of grate cannot be over six feet in length to work well, and therefore you have a fixed size of grate, but the heating surface of the tubes may be increased to a very large extent and so the grate area is small compared with the heating surface. The boiler is a quick steamer by reason of the large heating surface, and it may be taken as one of the safest forms of boiler from serious explosion by reason of the smallness of its various parts.

For the sake of comparison it may be stated that a Lancashiire Boiler, 30 feet by 8 feet, will have 1,000 square feet of heating surface and 38 square feet of grate area, which will give a ratio of over 26 to 1, while the water-tube with 1,000 square feet of he vill not have half the above grate area.

The great objectic o be is the effect of bad water on the boiler, and the mul ch have to be absolutely tight, for leakage in a water-t ince.

MANAGEMENT OF BOILERS.

In fixing our boilers plenty of room should be allowed in the flues. This is, perhaps, more necessary in the case of destructor boilers than any other, although even in the case of coal-fired boilers it is necessary that the plates be kept clean both on the water side and the fire side, and if the flues are cramped the flue-cleaning is not so likely to be thoroughly done as it is if there is plenty of room, and a very slight deposit on the plates at the fire side makes a material difference to the steaming of the boiler.

Another reason for plenty of room in the flues is of even a little more importance than saving a little coal or fuel in a week, or the saving of 200 or 300 fire-bricks in construction. It is the humanitarian reason, for, make the conditions of flue-cleaning as good as you can, it is a dirty, disagreeable job. In a destructor plant, although there is not a very great deposit on the plates, the amount of dust is considerable. In the working of boilers the fittings should be kept in good order, and particularly the safety valves and pressure gauges, the former to prevent any overloading of the boiler, and the latter to at once indicate it should it by any accident take place. The water gauges are also amongst the most important fittings of a boiler, and must be regularly blown through, as there are more accidents due to neglect of the water gauge than all other cases put together.

The feed-water arrangements should be in duplicate, and check and feed valves should be kept thoroughly clean and be frequently examined.

Leakages should be carefully sought for if there is any dampness found in the flues at cleaning; and leakages of cold air into the flues should be carefully stopped, as any leakage of cold air into the flues is a great source of waste of heat. If the water is at all bad or muddy a portion of it should be frequently blown out, and the boiler should be emptied and refilled as often as convenient. It is essential that the blow-off cock should be in good order and perfectly watertight.

Having in a casual way looked up the pedigree (the Farms Committee should fully understand that word) of our boilers, and having seen the method of construction and some notes on boiler management, it now remains to compare notes with respect to the three kinds of boilers with which destructor works are most concerned.

The only two cases where reasonable results are obtained with multitubular boilers are at Montagu Street, Birmingham, and Hammerton Street, Bradford, and while at Birmingham the steam raising result is high (although I have not a copy of the figures), I believe it is a fact that the wear and tear is very high, owing in a great measure to the boilers being over the top of the fire. I believe Mr. Darley. Leeds, also has some multitubulars: perhaps he will give his experience of them. At Bradford, in a test made not long ago, ·725 pounds of water was evaporated per pound of refuse. Considering the setting of the boilers this is, no doubt, a good result, but probably it would have been much better had there been more heating surface in the boilers. There are a large number of works where this class of boiler is used, and where a cheap installation is required or a small quantity of steam only is necessary. No doubt it will answer its purpose. As usually fixed, a large quantity of heat gets away to the chimney, and as its storage capacity both for steam and water is very limited, it is extremely difficult to keep the steam pressure steady. As an instance of this I may mention a test made December 21st, 1898, at the Torquay Destructor, when during a 12-hours run the steam pressure varied from 38 pounds per square inch to 105 pounds, and the average of thirty-one readings was 57 pounds per square inch. Such a result speaks for itself, but in a plant requiring anything like a regular supply of steam, such an arrangement as would allow the steam to vary in pressure 67 pounds and the maximum only be 105, would be simply intolerable.

The water-tube boiler, as usually built for the power given off, occupies less room than the Lancashire, and it is a quick steamer, but while it steams quickly and is quickly got up and at work, it also quickly falls, or rather falls much more rapidly than the Lancashire by reason of the steam and water storage being so much less. For the same reason, if the steam begins to run down it will drop lower in the water-tube than in the Lancashire of the same power.

We were told years ago about the detrimental effect of the gases from the refuse on the boiler plates ; this, however, does not seem to have been borne out by fact, as boilers have been working with refuse something like twenty years and are still in good condition.

This goes to show that burning refuse is really no worse for the boiler than burning coal : in fact, the wear and tear may not be so great as in burning coal by reason of the range of temperature being less, and the racking strains, consequently, less.

No doubt the best steam results can be obtained if the refuse is fired into the ordinary boiler firebox, especially if a forced blast is applied ; but while this method will give a good result in steam, the gases produced are not thoroughly burned, by reason of the cooling action of the comparatively cold boiler plates, before the combustion is complete. As a sample of what can be done in this way, I will now give you a test that was made at the Salford Sewage Works in 1895.

EVAPORATIVE TEST OF UNSCREENED ASHPIT REFUSE BURNED IN A LANCASHIRE BOILER 28 FEET × 7 FEET, WITH 33 INCH FLUES, AT THE SALFORD SEWAGE WORKS, MODE WHEEL.

Date of Test, 19th and 20th February, 1895.

Duration of test	14 hrs. 10 min.
Average steam pressure	50·5 lb.
Average temperature of feed-water	42·9° F.
Weight of refuse burned	18,704 lb.
Water evaporated	36,000 lb.
Water evaporated per hour	2,540 lb.
Refuse burned per hour	1,320 lb.
Water evaporated per lb. of refuse—actual conditions ...	1·9 lb.
Water evaporated per lb. of refuse from and at 212° F. ...	2·28 lb.

While the results obtained in steam production are very good by this very simple method of burning refuse, the fact of the incomplete combustion tells against it, and, altogether, this is a method not to be recommended.

It is, however, interesting, as show [illegible] can be done even in this rough and ready manner ; and to notice [illegible] ther methods may be more sanitary, they are not so efficient f [illegible] sing point of view.

Sewage Works, as a rule, are just on the outskirts of our towns and cities, and, at these places, fuel is often an important item on the expenditure side of the balance sheet, and, while fuel is usually paid for and carted considerable distances to these works, the ashes and refuse in the adjoining neighbourhood are also carted, comparatively speaking, a long distance away, either to a tip or to a destructor in another part of the town.

To avoid a state of affairs like this, J. Parker, City Engineer, Hereford, converted his coal-fired boilers into destructor-fired boilers, by placing a destructor cell in front of each, and the result has been that the whole of the pumping of one-and-a-half million gallons of sewage in 10 hours, daily, on an average to the height of 36 feet, together with the working of the presses and mixing plant, has, since the alteration was made nearly two years ago, been worked by the use of refuse alone, the whole of the coal bill being saved. This is done with the refuse from that part of the City nearest the Works, about one-third of the total refuse of the City being used in this way.

The results here obtained are very satisfactory from a steaming point of view, and they must also be so from a financial aspect, the whole of the coal being saved; it is also an interesting application of one class of refuse assisting in disposing of another class of refuse, while at the same time it is itself being disposed of in a sanitary way, and in the most approved manner, viz., by fire, and with perfect combustion. Of course, the clinker remains, but even this may be used for filters or bacteria beds, when crushed and screened to size.

We will now compare the results obtained with the different kinds of boilers at different places, and, while the refuse may vary somewhat, it cannot be responsible for one quarter of the difference in the results obtained.

	Boiler.	lb. of water evaporated per lb. of refuse.
Torquay ...	Multitubular	·334
Warrington	Water-tube	1·14
Salford ...	Lancashire, internally fired ...	1·9
Hereford ...	Lancashire, cells in front of boiler ...	1·58 May 4th.
" ...	" " " " ...	1·60 May 5th.
" ...	" " " " ...	1·82 May 6th.

From this it will be seen that one of the latest plants with multitubular boilers did not, on test, do one-fifth of the steam-raising that is shown by the average of three Hereford tests, and not much more than one-third of the result as shown by the water-tube, and the fact remains that the Torquay plant is doing little besides burning the refuse, whereas the Hereford plant not only does that, but works the whole of the sewage plant with, approximately, one-third the refuse of the City.

To put the matter in another way, the Torquay destructor will have to burn five tons of refuse to produce the same weight of steam that the Hereford plant does in burning one ton. The results obtained by all are better than were obtained some 10 or 12 years ago, and, regarded in that light, progress has been made.

Further progress will, no doubt, be made in the near future, and we are doing something towards it by comparing methods, as well as notes, at this meeting. If I have put anything before you that is new to you, or if I have put old matter before you in a new light, then I think you will agree with me that our time has not been wasted ; but if, while doing that, I have at the same time awakened fresh possibilities in your minds, which may be quite beyond my abilities, in refuse destruction and steam-raising, then indeed will the Glasgow meeting of the Cleansing Superintendents be a memorable one.

SPECIFICATION FOR MODERN HIGH PRESSURE STEAM BOILERS OF THE LANCASHIRE AND WATER-TUBE TYPE FOR USE IN CONNECTION WITH A COMBINED SCHEME FOR A REFUSE DESTRUCTOR AND ELECTRIC LIGHTING.

LANCASHIRE BOILERS.

Type.—The boilers to have a cylindrical shell with flat ends and two internal flues, made to the following specification :

General Dimensions.—Length 30 ft., diameter 8 ft., the flue tubes 3 ft. 2 in. internal diameter, the latter reduced as afterwards described therein.

Working Pressure.—The boilers to be suitable for a working pressure and a safety valve load of 200 pounds per square inch.

DIMENSIONS OF PLATES, RIVETS, ETC.

Description of plates, etc.	Thicknesses of plates, &c. inches.	Width of plates. ft.	ins.	Diameter of rivets and holes. ins.	Pitch of rivets. ins.
Cylindrical shell	⅞	6	0	⅞ ring seams	Transverse 2½ Diagonal 2½
Butt straps ...	⅞	1	3	⅞ shell, longitudinal seams	Outer row 6½ Four inner 3¼ Diagonal 3¼, 2½
Flue tubes ...	⅝ and ¾	2	6	⅞	Pitch 2½

Description of plates, etc.	Thicknesses of plates, &c. inches.	Diameter	Diameter of rivets and holes. ins.	Circumference. ins.
End plates	⅞	8 11	⅞ end to angle 2½	2½
		Width of plates		
End angle ring	¾ see	5½ × 5½	⅞ see ring seams	—
Gusset plates ..	¾	—	1⅛ to end and shell	2½
Gusset angles ...	¾	3½ × 3½	1⅛ to end and shell	2½

Shell.—The shell shall be 8 ft. internal diameter measured at the smaller rings of plates, and to be of a perfectly cylindrical form. The first ring at the front end to be an outer one, and each ring to be about 6 ft. in width, which allows for overlap on the ring seams. Each ring of plate to be in one piece, and to be gradually bent cold to the true circular form by the rolls without any hammering. The lay of the plates to be parallel, there being six rings in all, three outer and three inner rings; all to be 15/16 in. uniform thickness. None of these plates to be heated during the construction of the boiler, the edges and ends of all plates and butt straps to be planed. The longitudinal seams to be so arranged that they do not come in contact with the brickwork.

Butt Straps and Rivetting.—The longitudinal seams to be treble rivetted, butt joints with inner and outer butt straps of equal width and 13/16 in. in thickness, there being six rows of rivets. These seams, one in each ring, to be alternatively in position. The butt straps to be cut from plates of the same quality of steel as the shell plates, and have the fibre in the same direction as the plates they unite.

Butt straps to be drilled in position, and afterwards taken apart to remove all burrs from the holes before rivetting. The transverse or ring seams of the shell, and the front end angle-ring to shell to be double-rivetted lap joints, and the front end plate double-rivetted to the front end angle; the pitch of the rivets in the double-rivetted transverse seems to be 2½ in. with a diagonal pitch of 2½ in., with rivet holes 15/16 in. in diameter.

Rivets.—All the rivets used must be of the best mild steel.

Drilling Holes and Size of Rivets.—All rivet holes throughout the boiler shall be drilled and the holes be quite fair with each other, those in the cylindrical shell to be drilled when the plates and straps are bent to a true cylindrical form and bolted together in position. The plates and straps must afterwards be taken asunder and all sharp edges and burrs left by drilling taken off. This must be done with all the rivet holes, and all the caulking and fullering done so as not to indent or injure the surface of any of the plates. The ends of the straps shall be butted or thinned, but if the latter, the thinning must be by machine, and all carefully fitted that the cylindrical form of the shell shall not be interfered with. The rivets of the shell at the longitudinal or ring seams to be 17/16 in. in diameter. Those in the longitudinal seams to be pitched or spaced 6½ in. apart in longitudinal direction, centre to centre, in the two outer rows, and 3¼ in. apart in the four inner rows. The inner and outer cover straps to be 15 in. wide and to embrace the six rows of rivets. The rivets at the seam of the back of end plate flange to shell, and at seams of front end angle to end and shell, to be spaced 2½ in. apart along the seams and 2½ in. in diagonal direction. The holes for the rivets connecting the rings of the flue tubes to end plates to be $\frac{15}{16}$ in. in diameter, and spaced 2½ in. apart centre to centre. The holes for the rivets attaching the angle ring of the shell to front end plate to be drilled $\frac{15}{16}$ in. in diameter. All the rivetting must be done by machine except where quite impracticable.

Ends.—Each of the ends to be in one piece $\frac{15}{16}$ in. thick. The front end to be attached to the shell by angle ring, and the back end to be flanged. The openings in the end plate for the flue tubes to be truly bored out, and the outer edges of both plates, and the edges of the front and angle ring to be turned up.

Angle Rings.—The angle ring to be 5½ × 5½ × ⅞ ins. finished section.

End Stays (Gussets).—The end plates to be supported by six gusset stays at each end above the tubes, and below the tubes three at the back end, and two at the front end. The gusset plates to be ¾ in. thick, and the gusset angles to be 2½ × 3½ × ¾ ins., the holes in the gusset angles and shell to be 1⅛ in. diameter. The gusset angles to be single rivetted to both ends and shell plates.

Double Angles.—All gusset stays to be firmly rivetted to double angles, the angles to be carefully placed so as to grip the stay plates, and the rivets must fill the holes in both angles and plates. The rivetting of these to be as follows :—The gusset stays to be attached to the angles and the angles to the end plates and shell, the rivets and holes 1⅛ in. in diameter, and spaced or pitched 2½ in. centre to centre.

Breathing Space.—In order to allow for expansion, the distance between the rivets of the furnace and flue tube flanges, and the nearest rivets attaching the gusset angles to end plates must be, for those above the tubes at both ends, 10 in. centre to centre, and for those below the tubes at front end, 4½ in. centre to centre, and for those at the back end, 6 in. centre to centre.

Dispersing Pipe Supports.—Suitable angle brackets for carrying the anti-priming and feed dispersing pipes, must be rivetted to the shell of the boiler internally, in accordance with instructions to be given later.

Flue Tubes.—The flue tubes must be of a truly cylindrical form, 3 ft. 2 in. internal diameter, with the exception of the last ring, which must be 2 ft. 8 in. internal diameter, each ring being in one plate ⅝ in. thick, except the first and last rings, which must be ¾ in. thick, soundly welded at the longitudinal joint, this being in the lowest part of the tube ; all welds of the flue tubes to break joint at the bottom of the flue tubes. The flanged seams to be in position specially arranged so that no seam shall be over the furnace fire bridge. The seams to be formed by flanging the plates to a curve having an inner radius of not less than 1 in., and a flat not less than 2⅛ in., the caulking ring being 2¼ in. wide × 7/16 in. thick.

The flat to extend ⅛ in. beyond inner edge of ring to facilitate caulking. The flanges must be turned upon their outer edges. The second plate from the back end of flue to be coned down to 2 ft. 8 in. in diameter. The last ring plate to be cylindrical.

Annealing.—All plates worked hot to be annealed where possible, or to be gradually cooled so as to avoid local stress.

Manholes.—The manhole to be in the centre of the second plate at top back end, and the mud-hole to be at front end centrally below the flue tubes. Both to have an extra strong joint bed with planed faces, and to be large enough for a man to pass through. That for the mud-hole to be mild steel, the opening to be of an oval form to measure 15 in. horizontally and 11 in. vertically. The cover to be of steel, secured by two 1¼ in. bolts, with suitable cross-bars of wrought iron. To avoid the risk of the packing ring being blown out the raised portion of the mud-hole cover must be carefully fitted into the mouth-piece, and the clearance must not exceed ⅛ in. : that is, 1/16 in. on each side. The manhole to be 16 in. in diameter, and the mouth-piece to be of mild steel ¾ in. thick throughout, except the top flange, which must be 1 in. thick. The manhole cover to be of mild steel, "dished," and to be attached by eighteen 1⅛ in. bolts with faced nuts.

Maker of Manhole.—Both rings and doors of manhole and mudhole to be made by........................

Strengthening Ring and Rivetting of Manhole.—A strengthening ring to be fixed around the opening in the shell, the strengthening ring to be 15/16 in. thick, attached by treble rivetting similar to that of the longitudinal seams. The manhole mouthpiece is to be attached to the shell by double rivetting, spaced about 2½ in. along the seam, and 3¼ in. diagonally, the rivets passing through the manhole flange, shell, and strengthening ring.

Mounting Blocks.—Suitable seating blocks of mild steel to be carefully fitted and rivetted to the shell, all to be turned on the edge, and truly faced and recessed on the joint face to receive the fittings; the flanges of the blocks to be of thoroughly adequate thickness, the lower flanges being not less than ⅝ in. thick; two-faced steel block pad, not less than ¾ in. thick, to be rivetted either on the front end plate or on the first ring of the shell, as may be determined later for the feed valves.

Quality of Steel.—All the plates and angles to be ductile steel, made by Siemens-Martin process, with a tensile strength of not less than 27 tons and not more than 30 tons per square inch, except the furnace plates, which must have 24 to 28 tons tensile strength; the elongation of all in a length of 10 in. to be not less than 20 per cent. The number and the maker's name (or trade mark) to be stamped outside in at least two places on each plate.

Test Pieces.—Suitable strips of plate cut from that taken out for the mudhole and for those parts cut and planed so that any bending or tensile tests may, if required, be made.

A list of plates and samples of test strips to be furnished by the makers, giving the consecutive index numbers of each, with its breaking tests and elongation as obtained by testing strips therefrom.

Hydraulic Test.—The boiler to be tested to 350 lbs. per square inch hydraulic pressure, which must be steadily maintained for half an hour. All seams to be made tight under pressure, and all parts of the boiler made good before leaving the maker's yard.

Supervision, Inspection, and Examination during Construction.—The boilers will be subject to examination during construction by the..........................

SPECIFICATION FOR WATER-TUBE BOILERS.

General.—This specification provides for the delivery and complete erection of water-tube boilers and superheaters as hereinafter mentioned.

Total Heating Surface. Evaporation per Hour.—The boilers to have each a total heating surface of———square feet, and each boiler to be capable of evaporating ——— lbs. of water per hour when burning refuse.

Working Pressure.—The boilers to be suitable for a safety valve load and working pressure of 200 lbs. per square inch.

Sections of Tube Slabs.—Each boiler is to be composed of ——— sections or slabs, each section being composed of ——— best lap-welded wrought tubes ——— in diameter, and in suitable lengths, connected at the ends by continuous staggered headers or "up-takes" and "down-takes," the tube joints being made therein by an expander.

Headers and Water Connections.—The headers are to be made of steel, and to be provided with hand-holes placed opposite the end of each tube of sufficient size to permit the cleaning, removal, and renewal of a tube through the same, each hand-hole being provided with a cap fastened with wrought iron bolt clamp, and cap nut. The several sections are to be connected at each end to steam and water drum, and at the rear end with a mud drum by means of lap-welded wrought tubes ——— in diameter, and of suitable lengths, the joints being made with an expander.

Steam and Water Drum.—The steam and water drum shall be ——— internal diameter, measured at smaller rings of plates, and ——— long, exclusive of the dished ends, made of mild steel plates ⅜ in. thick, the longitudinal seams to be butt joints and double rivetted, these seams, one in each ring, to be alternately in position and arranged that they do not come in contact with the brickwork. A manhole to be provided at one end 15 in. by 11 in.; this to be made by........................

Mounting Blocks or Nozzles.—Three wrought steel mounting blocks or nozzles, two for safety valves and one for taking off steam, 7 in. in diameter, with 13½ in. flange, faced and recessed on their upper surface for spigot and socket joint, turned edges and drilled; also one steel T piece for superheated steam stop valve, and one auxiliary nozzle at front end of drums 2½ in. in diameter, and two wrought steel blocks for feed valves. All mounting blocks or nozzles to have suitable strengthening ri

Cross Drums.—If cross drums are supplied, they are joined to the steam and water drums at the rear end, to be —— in diameter, fixed to the main drums by expanded connections, and fitted with outlets for main steam stop valve.

Superheaters.—Each boiler to be fitted with an approved superheater capable of imparting from 100 deg. to 120 deg. Fahr. of superheat to the steam produced by the boilers.

Mud Drum Blow-off.—The mud drums shall be wrought steel metal ——— diameter and ——— long, with hand holes and a nozzle for blow-off pipe ——— in diameter, and to be of sufficient capacity and strength to withstand all strains due to steam pressure, expansion, etc.

Supports.—The boilers shall be suspended from wrought iron girders, resting on wrought iron columns, with approved cast iron bases properly secured, so that the boilers shall be sustained entirely independent of the brickwork, and free to expand or contract without affecting the same, and so that the brickwork may be removed and replaced, if required, without disturbing the boilers or connections.

Fronts.—The front of the boilers shall be of the usual standard pattern, preferably in sections bolted together, containing the necessary doors suitable for adoption with refuse destructors, and large doors for access to the ends of the tubes. All parts to be ample in strength, joints to be fitted.

Fixtures.—The fixtures of each boiler are to consist of a full set of grate bars with bearers, dead plate and girders, flame bridge plates with bolts and special firebrick for lining the flame bridges ; bridge wall girders and bars, binders and bolts, two ash and five cleaning doors with frames bricked in for access to the exterior of tubes and the flues for cleaning ; one damper with frame, and the requisite lintels for opening in walls, smoke chamber, and anchor bolts for front.

Furnace.—The furnace to be constructed for burning refuse and coal if necessary.

Spares.—

No. —— Gaskets for manhole door in steam and water drum.
,, —— Sets of fittings for handhole door in mud drum.
,, —— Complete sets of handhole fittings.
,, —— Gauge glasses with washers.
,, —— Cap wrenches fitting the small handhole nuts.

Tools.—

No. —— Cap wrenches fitting the large handhole; nuts are to be of ample strength.

" —— Suitable tube scrapers with handles.

" —— Sets of spanners to fit all nuts on the boilers, and fittings to be ample strength for the purpose intended.

Steam Jet Pipe.—

No. —— One set of steam jet soot cleaning pipes with all valves, pipes, and connections arranged in the flue for cleaning tubes.

Hydraulic Test.—The sections, mud drums, steam and water drums, shall be tested and made tight under a hydraulic pressure of 350 lbs. per square inch. The boiler, when complete after erection, shall again be tested to a hydraulic pressure of 350 lbs. In each case the pressure to be maintained steadily for half an hour.

Space.—The space occupied by the boilers, including brickwork, is to be shown on plans to be submitted.

Delivery.—The boilers to be delivered on site at ....

Guarantee.—With each proposal the contractor must state:—

(1.) The quality of steel plate to be used in the construction of each boiler, and also the make of tube. A special price to be filled in the schedule for solid drawn tubes throughout as an alternative to lap-welded tubes.

Time of Delivery.—..............................

Supervision, Inspection, and Examination during Construction.—The boilers will be subject to examination during construction by the..................................

CHAPTER No. VIII.

BOILER SETTING, BRICKWORK AND FLUES.

THE setting of boilers in such a way as to ensure, firstly, thorough cremation, and then the highest efficiency from the available heat, is a matter which requires most careful consideration. Earlier experience with destructor and power plants show us two extremes in the position of the boiler. On the one hand it was placed at such a distance from the boiler that the temperature of gases was so seriously reduced in the long travel as to be of little service by the time the boiler was reached.

The other extreme was to place the boiler immediately over the fire, much in the same way that the domestic kettle is pushed well down into the fire. The latter extreme differs from the first in this very serious aspect : that with the former, nuisance might be avoided, whereas in the latter case it was inevitable.

To use the steam boiler as a kettle—to place it immediately over or in the fire—is simply to thwart the primary function of the destructor and to reduce it to impotence. The modern destructor being essentially a steam-raising plant, the position and setting of the boiler is a matter of vital importance, and, although rival destructor-makers do not all agree as to the best position of the boiler, yet they will allow that the position and setting of the boiler are important factors in determining the all-round efficiency of a plant, or otherwise. With regard to the setting of the boiler, when once the site is decided upon, great care is necessary. Few, excepting those immediately concerned with this class of work, have any idea as to what loss of efficiency may be caused by bad setting ; how not to do it has been shown again and again, principally in connection with works and mills, and in the early days of refuse destruction.

A few years ago it was, to a large extent, customary to hand the boiler over to the local bricklayer to set. This wily individual employed as much brickwork as possible, and made the job lengthy, costly and unsatisfactory.

That a great deal of this class of work has been given to the incompetent and the inexperienced is evidenced by the fact that there are at the present time a number of practical boiler setters who, for years past, have made a good living at resetting boilers, taking away quantities of unnecessary brickwork, enlarging and reconstructing narrow and contracted flues.

Many cases could be cited where over 25 per cent. less fuel has been burned, and in other cases the steam production has been largely increased, and this by proper boiler-setting alone. Loss of efficiency is not the only trouble which has to be faced with boilers badly set; the setting is an important factor in fixing the life and repair bill of the boiler. All unnecessary brickwork is not only rendering useless what should be effective heating surface, but, if there is any dampness at all, thus covered up by brickwork, corrosion goes merrily on, undetected.

On the other hand, when a boiler is set in a modern manner with Poultons', Stokes', or other approved blocks, much more of the external surface of the boiler is accessible as effective heating surface, and it can be readily got at for the periodical examinations.

With bad setting, contracted flues, too much of the boiler covered up and parts quite unapproachable, it is only too obvious that boiler inspectors are thwarted in their efforts to make a thorough examination.

Now with reference to flues, these should be capacious; the old theory as to the value of narrow flues for boilers has long since been exploded. It will be at once seen that if roomy flues are advisable for boilers fired with coal, it is highly necessary that they should be even of larger area when boilers are fired with gases from destructor cells, mainly, of course, because the deposit is considerably greater and more rapid.

Again, roomy flues give a proper circulation of the gases, and so tend to a thorough utilisation of the heat, while at the same time equalising the temperature between the top and bottom of the boiler as much as possible.

Just as it is essential that the brick flues of boilers should be amply large, so it is with all flues in connection with the cells; when ample sectional area is provided the velocity of the gases is reduced, giving the suspended dust an increased chance of settlement.

Sufficient flue area will enable a plant to be operated for longer period. Under the very best conditions the dust deposit is a serious matter; plenty of room will facilitate the flue cleaning, which, at its best, is an exceedingly laborious job.

Another point to be borne in mind in connection with flues is the provision of sufficient manholes, at not too great a distance apart; a distance of from 25 to 30 feet should not be exceeded. The advantage will be found when the time for flue cleaning arrives; the flues can be cooled more rapidly, and the dust can be got out quickly at a number of different places.

These may be considered very minor points by some, but careful provision made in this way in design will be the means of saving much time and labour.

Various methods have been employed for the interception of flue dust, and all may be said to have been simple and efficient. Some years ago the escape of dust was responsible for a great deal of trouble; in fact, it was a nuisance, but strange to say, unlike most nuisances, it has not been the means of bringing forth extraordinary and complicated remedies. On the other hand, whatever devices have been introduced for preventing the escape of dust have been of the simplest character, but none the less successful.

Various dust traps have been tried. One very successful one was that introduced by Mr. B. D. Healey; it was built across the main flue and was provided with air-tight hinged covers, the cover being manipulated from the outside, and, when in use, was set at such an angle against the current of gases as to act as a deflector. The trap could be readily emptied from the outside at intervals, without admitting cold air into the flue.

Another successful device is Horsfall's Dust Catcher. An illustration (Fig. 9) is here shown of one of these in course of construction at Ramsgate.

To briefly describe the Dust Catcher, it consists of a circular brickwork chamber, sometimes as much as 18 feet in diameter and 16 feet in height, lined with firebrick. In the centre is built an inner circular chamber connecting to the surrounding annular space, through an opening at the top of the wall. The main flue from the cells enters the annular chamber at the bottom, the gases having to pass round and up through the outer chamber before entering the central one, passing from the bottom of this to the boiler.

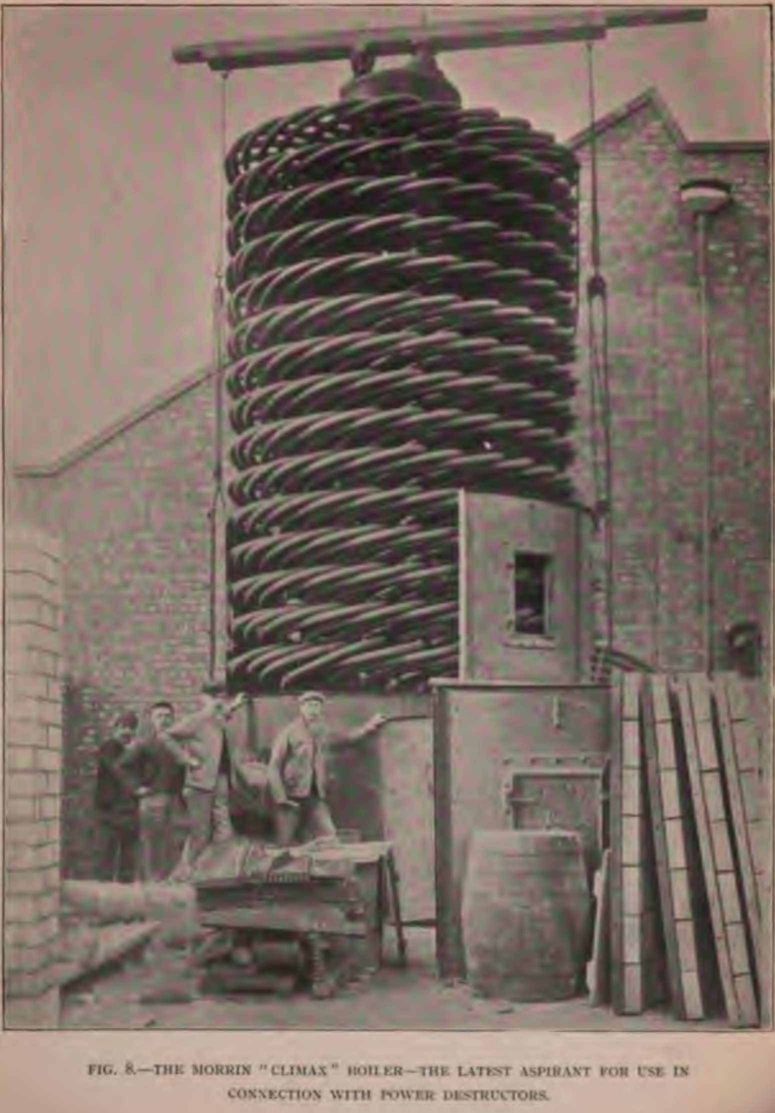

FIG. 8.—THE MORRIN "CLIMAX" BOILER—THE LATEST ASPIRANT FOR USE IN CONNECTION WITH POWER DESTRUCTORS.

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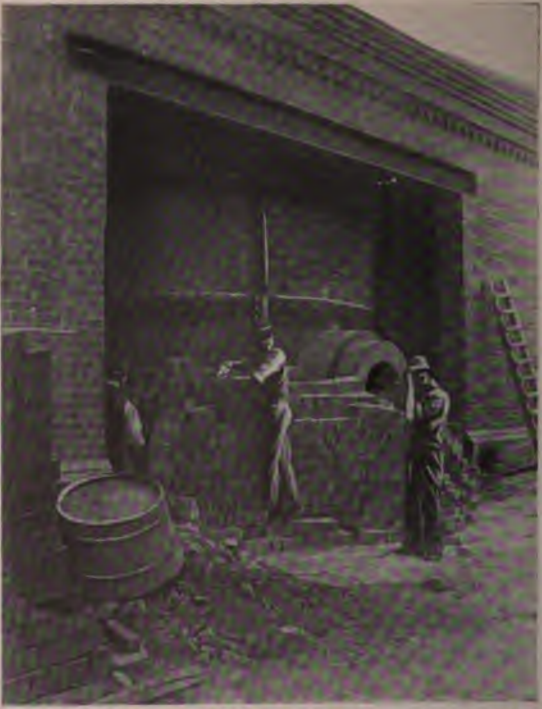

FIG. 9.—HORSFALL'S DESTRUCTOR AT RAMSGATE, SHOWING DUST CATCHER IN COURSE OF ERECTION.

The suspended dust is carried by the centrifugal action and lodged in dust pockets, each pocket being provided with an external door for access and cleaning out.

✓ With regard to dampers, these, like all other destructor accessories, should be as simple as possible. General experience has shown that the ordinary type of carefully counterbalanced damper, working in a slotted frame, is the most reliable for the present high temperatures.

✓ They are often jacketed with the best firebricks or slabs, and then do not give much trouble, but a multiplicity of dampers should be avoided.

CHAPTER IX.

CHIMNEYS AND DRAUGHT.

THE chimney, being an essential part of every destructor scheme, calls for careful consideration, although, as I shall proceed to show later in this chapter, the function of the chimney is gradually changing from that of a draught producer to a mere outlet for the products of combustion.

Nevertheless, all such radical changes must be more or less gradual, and in the case of the chimney shaft there are peculiar reasons why the evolution will be very gradual indeed.

It is for this reason that it will be in keeping with the general idea of this work to first of all consider the chimney as applied for the two-fold purposes originally intended.

1. To cause a sufficient current or pull of air through the fire to consume the fuel with the minimum waste of heat.

2. To discharge at a reasonable or great height, the hot gases and products of combustion, smoke and noxious fumes, which would be a nuisance and injurious if ejected at a low altitude.

The above are given as the functions of a chimney, I may say, as originally intended to meet given circumstances. Circumstances which do not arise to the same extent to-day, and with the progress being made are not likely to be so frequently met with in the future. To take function No. 1 first, the chimney under average conditions does not, strictly speaking, fulfil this requirement, the reasons being various, a few of which we will consider.

(*a*) A chimney is, to some extent, dependent upon natural conditions, which may, or, may not, exist ; when the barometer is low and the air temperature is high, difficulty is often experienced and a chimney good under favourable conditions is sluggish. Do we not often hear it said by an engineer, "I cannot get steam to-day—the wind is in the wrong quarter"?

(*b*) With regard to the air supply, this, of course, can be controlled by dampers, but probably there is no part of a steam plant that is so consistently neglected as the damper. A damper at its best does not lend itself to a very fine and careful adjustment of air supply, and if the fireman is left to his own devices he will have it wide open, and he will tell you "to steam easy." What is the result? If the chimney is a powerful one, a great excess of air is pulled through the fire, great waste is caused—the excess air has all to be heated at the expense of so much extra fuel.

I mention such a case as this, because so many have the idea that an enormous chimney is a necessary and valuable adjunct to a steam or power plant. Analysis of the gases often shows that a powerful chimney is a monument of colossal waste. Now we will take function No. 2. This is undoubtedly performed by a high chimney, but even then Nature will step in at times and thwart all efforts. Noxious products may be discharged high, but we do get certain winds which will beat the fumes down; we get other winds which carry them straight to rising ground, when same exists, and as residences are often situated in such parts of a town Nature links them with the high chimney top.

If we hark back for a moment to the day of the low temperature destructor, which was invariably provided with a high chimney, what do we find?—nuisance and constant complaint. The powerful chimney was in use, but nuisance was not prevented.

According to Mr. Brierley Denham Healey, the following is an analysis of the various chimneys in use at destructor works:—

180 ft. in height, equal 52 per cent.
160 ft. in height, equal 13 per cent.
150 ft. in height, equal 18 per cent.
120 ft. in height, equal 12 per cent.
105 ft. in height, equal 5 per cent.

SOME HEIGHTS OF CHIMNEYS AT DESTRUCTOR WORKS.

Aston Manor ...	180 ft.	Blackburn	300 ft.
Batley	150 ,,	Blackpool	120 ,,
Battersea	180 ,,	Bolton	[illegible]
Birmingham, 2 (each)	150 ,,	Bournemouth	
Birmingham, 1 ...	260 ,,	Bradford, 3 (each)	

Bradford, 1	130 ft.	Hyde	180 ft.
Bristol	180 „	Leicester	160 „
Burton-on-Trent	140 „	Liverpool	175 „
Bury	180 „	Longton	150 „
Buxton	150 „	Nottingham	160 „
Cheltenham	160 „	Preston	180 „
Derby	160 „	Rotherham	130 „
Ealing	143 „	Royton	180 „
Eastbourne	140 „	Salford (North)	180 „
Govan	120 „	Salford (South)	180 „
Hampstead	120 „	Southampton	160 „
Hastings	130 „	Warrington	150 „
Heckmondwike	120 „	West Derby	160 „
Huddersfield	180 „	Whitechapel	180 „
Hull	180 „	Woolwich	160 „

Each installation mentioned in this list was originally of the low temperature type, although some have had artificial draught added since; the general uniformity of height will be apparent.

Prominent among low chimneys for modern installations may be mentioned Aldershot, 10 tons of refuse per day; chimney 70 feet. Hereford, a similar quantity per day, with a chimney only 45 feet high. Plumstead Vestry, in inviting tenders for a destructor and power plant, suggest in their specification a chimney 80 feet in height. The quantity of refuse to be dealt with here will be 60 tons per day, and in addition to taking the gases from the cells this chimney will also have to serve for some supplementary boilers in connection with the electric lighting.

Thus it will be seen that the tendency of the best modern practice is toward a low chimney, which will, of course, be amply large in sectional area. Such chimneys would not be possible if noxious fumes and nuisance were inseparable from destructors; that is obvious, and those makers who still demand a high and powerful chimney must not complain if their desire is taken as conveying that they cannot promise immunity from nuisance.

In many districts there are local bye-laws governing the erection of chimneys and providing a minimum height, usually about 75 feet. This, of course, is in some of the large towns and cities.

Where it is contemplated to discharge gases direct from cells into a chimney without greatly reducing the temperature by absorption for power purposes, it is necessary to provide a good fire-brick lining. The cohesion of mortar is soon destroyed with a high temperature, and trouble speedily ensues; cracks, more or less serious, present themselves, and, what is often a very serious expense, the placing of wrought-iron bands round the chimney from top to bottom at regular intervals has to be faced. This was the case some two years since with the Kelvinhaugh Destructor Chimney, Glasgow: if I remember correctly, to band this fine chimney cost some £600. The primary cause of this was the destruction of refuse without utilising the heat resulting therefrom.

It is not necessary to deal at any further length with this point, as it is now generally recognised to be a mistake to burn refuse and waste the power available.

If we go back to the earliest history of the chimney, it will be found that domestic chimneys even were not in vogue until after the time of the Norman Conquest, and when they did appear, strange to say, they were built horizontally, the exit projecting through the side wall of the house or building.

Homer, in describing the domestic life of the ancients, tells how they contrived to get their apartments warmed from a central *hypocaust*, or fireplace, the gases travelling therefrom through baked clay pipes, the ends of which were closed up by stoppers until the fire had burned clear. The stoppers were then removed, and the heated air allowed to circulate about the room.

This, while being historic and interesting, is digressing. I am, however, reminded of it by the prevailing tendency at the present time to considerably reduce the height of chimneys. This, I think, is likely to continue, and although we cannot approach the ancient system, yet modern steam-raising plants, as well as power destructors, are likely to be provided with chimneys considerably reduced in height.

With some modern destructor and power plants, it is true, high and powerful chimneys have been built, not altogether because they were an essential part of the scheme, but, firstly, to pander to the sceptic; secondly, to overcome sentimental sc [illegible] lly, with a view to large future extensions.

Given a free hand, some, at any rate, of the best makers of modern destructors would undoubtedly include a very moderate chimney indeed; but opposition is very frequently met, and, strange to say, it is most determined and hostile from those who have the least knowledge of the issues involved.

The signal success attained by artificial draught has shown and proved conclusively how unnecessary the high and powerful chimney is. In America, artificial draught—mainly induced draught—has made enormous strides, and bids fair to become practically universal. In this country also artificial draught has been very largely adopted.

The real utility of artificial draught, and its superiority over chimney draught, was never more conclusively demonstrated than in destructor work. Its advent was the means of lifting sanitary refuse disposal out of a lethargic and unsatisfactory condition, and placing it upon a sound practical basis. It cannot be denied that Horsfall's and Meldrum's success with the steam blast, and Young's and Deas' success with the fan blast was the means of lifting destructor practice out of the slough, and pointing the way to the best modern practice.

Artificial draught has not only been useful in obviating the use of powerful chimneys by burning the fuel independently of the chimney—either by an under-grate pressure, or a pull of air—but another great advantage over chimney or natural draught is that the air supply is under much easier and finer control.

When the air supply can be well regulated, it is obviously very much easier to reduce the supply of air near to the theoretical requirement, thus showing a high all-round efficiency. Again the question of air supply is an important factor in reaching and maintaining high temperatures.

So far as this country is concerned, the steam jet blower, or forced draught, is mostly in evidence with high temperature destructors, both with modern plants and those which have been "converted." I do not intend to enter into any argument to endeavour to prove which is the most economical in steam consumption—the steam jet blower or fan. I will say, however, that a well-designed steam jet apparatus is fully as economical as a fan, and in first cost and up keep it is very much cheaper.

Further, fans have to be provided in duplicate, in case of breakdown, while with steam jet blowers this course is quite unnecessary. ✓Again, with fans it is the common practice to use one or two fans to work common to a range of cells, and if, for some reason as may, and does occasionally, happen, only half of the cells are in use, the fan has still to be driven.

✓ On the other hand, with a steam jet blower apparatus, each cell, or portion of a grate, has its own distinct and separate forced draught arrangement; thus, if only one cell out of a whole battery is in use, that one is, at any rate, being worked economically and efficiently.

The steam jet blower has got into bad repute in some quarters, and is viewed with suspicion, because some makers have used a very large quantity of steam, but just as there are fans and fans, so are there blowers and blowers, and where steam blast is included in a scheme,✓ the purchaser should avoid any steam jet blower offered, if the maker will not guarantee a steam consumption of 15 per cent. as a maximum, with a given pressure of steam at jets, and a given quantity of refuse consumed per cell per 24 hours.

✓ Naturally, now the destructor is recognised as a power producer, it is of the highest importance that the *net* available steam power from a plant should be a "known quantity;" therefore, with a guaranteed gross evaporation, and a guaranteed steam consumption for producing the draught, the purchaser will be in a reasonable position.✓ On the other hand, with a guaranteed gross evaporation, and the steam to be deducted from that for draught an "unknown quantity," the position is extremely unsatisfactory.

✓ If fans are employed, it is, of course, equally necessary that the indicated horse power required to drive same should be guaranteed; artificial draught is a vital necessity in connection with destructor cells, and it is in connection with the cost of producing this draught that the author believes improvement in the way of economy can and will be effected.

I am led to this opinion by noting the tremendous and extravagant quantity of steam used in some cases to produce the draught. Instances could be cited where 30 per cent., and even over 40 per cent., of the total steam raised [illegible] cells is used for the purpose, and it may be said that if [illegible] consumption represented the best practice, then [illegible] grave doubt whether or not "the game is worth t[illegible]

In some recent specifications, makers have been invited to state definitely what chimney they would require with their plant, viz. :—(*a*) height (*b*) sectional area. The author ventures to think that the time is not far distant when those tendering will also be compelled to guarantee the quantity of steam they require for their fans or blowers. No doubt some will think such a requirement bordering upon the ridiculous ; personally, I think it is nothing but what is perfectly justifiable and logical.

If a chimney is designed and built to burn a given amount of fuel in a given time, it is an easy matter to find out what that chimney will cost ; it may then be paid for and so far done with. If artificial draught is used, the apparatus is paid for so far, as is the chimney, but with this difference, it will cost so much or so little in fuel, in steam every hour it is used; briefly it is a constant expense, inasmuch as so much useful energy is being always taken away. Therefore, is it not only reasonable that the purchaser should have a guaranteed steam consumption for draught ; in other words, a guaranteed cost ?

Where the available heat from a destructor is fully utilised it is possible to considerably reduce the height of the firebrick lining, even if it is not possible to altogether dispense with it.

The reason, of course, is that with a properly designed destructor and power plant, although the combustion chamber temperature may exceed 2000° Fahr., yet with boilers of ample heating surface, economisers, etc., the temperature of the gases may be reduced at the chimney base sufficiently low as not to be destructive, and yet not too low to take away the products of combustion.

Here, of course, I refer to the modern high temperature destructor provided with artificial draught. Where the chimney only is used to provide draught, it is impossible to reduce the temperature of the gases at the base to anything like the same extent. This may be explained by saying that, in the former case, the only function of the chimney is to pull the products of combustion from the top of the fire as liberated. In the latter case the chimney has not only to do this, but to burn the fuel also.

The fact that where forced or artificial draught is employed renders it possible for the gases to be discharged at a low temperature, is, in itself, a strong argument in favour of artificial

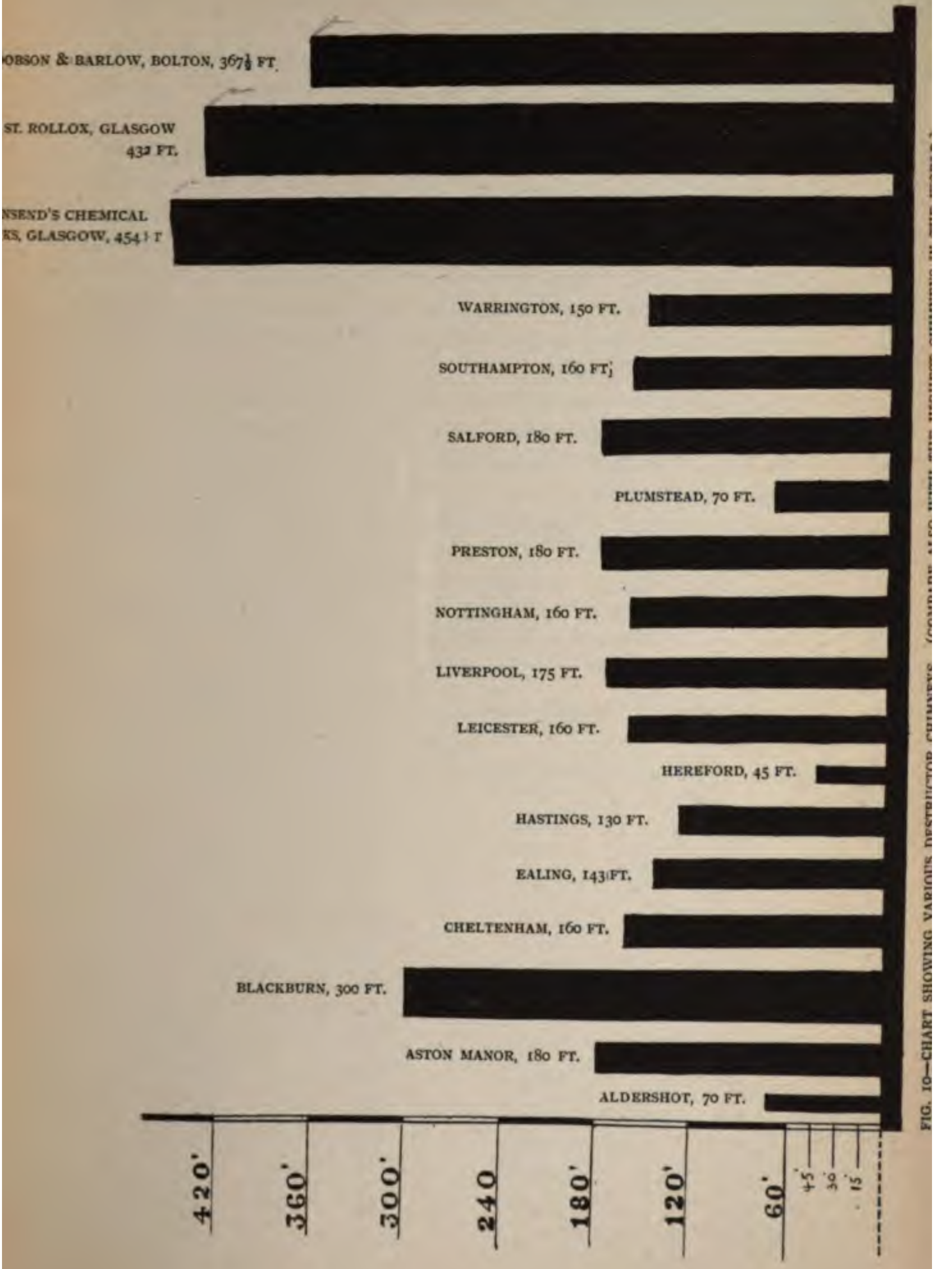

FIG. 10—CHART SHOWING VARIOUS DESTRUCTOR CHIMNEYS. (COMPARE ALSO WITH THE HIGHEST CHIMNEYS IN THE

draught. If 200° Fahr. extra can be taken out of the travelling gases and absorbed by effective heating surface, it must spell economy.

Some few years ago the author made a number of careful experiments in this direction, with a view to finding out exactly how low in temperature the gases could be reduced at the chimney base—without in any way reducing the general working efficiency. The very best results obtained were reached with the temperature at the chimney base reduced to 250° Fahr. At this time the flue gases were analysed, and several trials gave 16·75 per cent. of CO_2.

The nature of the fuel employed, however, would not allow this low temperature and high percentage of CO_2 to be maintained without vigilant attention. It was clearly shown, however, that a temperature of 300° Fahr. could be maintained at the base with a steady reading of 15 per cent. of CO_2.

CHIMNEYS.—TABLE OF THEORETICAL DRAUGHT POWERS WITH THE EXTERNAL AIR AT 60°, AND THE INTERNAL HEATED AIR AT 580°.

Height of Chimney in Feet.	Draught in Inches of Water.	Theoretical Velocity in Feet Per Second.	
		Cold Air Entering.	Hot Air at Outlet.
50	·367	40·0	80·8
60	·440	43·8	87·6
70	·514	47·3	94·6
80	·587	50·6	101·2
90	·660	53·7	107·4
100	·734	56·6	113·1
120	·880	62·0	123·9
150	1·101	69·3	138·6
175	1·285	74·8	149·6
200	1·468	80·0	160·0
225	1·652	84·8	169·7
250	1·836	89·4	178·9
275	2·020	93·8	187·6
300	2·203	98·0	196·0

HORSE POWER OF CHIMNEY SHAFTS TO STEAM [redacted] NOT MORE THAN 180 FEET LONG.

Size of Top Inside.		50 feet.		70 feet.		90 feet.		120 feet.		175 feet.		250 feet.		300 feet.	
Feet.	Ins.	Square.	Round.	Square.	Round.	Square.	Round.	Square.	Round.	Square.	Round.	Square.	Round.	Square.	Round.
2	0	57	45	68	53	—	—	—	—	—	—	—	—	—	—
2	3	74	58	87	68	—	—	—	—	—	—	—	—	—	—
2	6	90	71	107	84	121	95	—	—	—	—	—	—	—	—
2	9	—		129	101	146	115	—	—	—	—	—	—	—	—
3	0			154	121	174	137	201	158	—	—	—	—	—	—
3	6			—	—	237	186	274	215	—	—	—	—	—	—
4	0			—	—	310	243	358	281	432	339	—	—	—	—
5	0					—	—	560	440	675	530	807	634	—	—
6	0						—	806	633	972	763	1163	913	—	—
7	0						—			1323	1039	1583	1243	1735	1363
8	0									1728	1357	2067	1623	2265	1779
9	0											2616	2054	2867	2252
10	0													3542	2782

CHAPTER X.

REFUSE DISPOSAL IN LONDON SANITARY DISTRICTS.

Battersea—Here is a 12-cell destructor, erected by Messrs. Manlove, Alliott and Co.; each cell deals with 6 tons per 24 hours; a 60 horse power Multitubular Boiler was put down in connection with the cells, the cost for burning, including repayment of principal and interest for the year ending March, 1897, was 2s. 10d. per ton.

Bermondsey.—The Vestry recently contracted with Messrs. Hughes and Stirling to erect a destructor in combination with the Electricity Works.

Bethnal Green.—Here the refuse is partly sorted and sifted at a depôt, but the question of providing a destructor is under consideration.

Camberwell.—The refuse is barged away.

Chelsea.—The refuse is barged away.

City.—A 10-cell Fryer Destructor by Messrs. Manlove, Alliott and Co. was erected in 1884; each cell has a capacity of about 8½ tons per 24 hours; in connection with the cells is a Multitubular Boiler.

[1]According to the report of the Public Health Department of the City, the quantity of refuse removed during last year amounted to 45,044 van loads taken from premises, and 29,577 loads of sweepings and slop from the public ways, making a total of 74,621 loads, which is at the rate of 1,435 per week, or about 239 per day for a six-day week, there being no dust removal or sweeping of thoroughfares on Sunday.

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[1] Report by Mr. Ross, Engineer of Public Health Department of City of London for 1899. The accompanying table shows the quantity of refuse removed annually from the City of London during the last ten years :—

Year.	Street Sweepings and Slop.	House and Trade Refuse.	Total Loads.
1890	27,810	40,026	67,836
1891	29,821	41,234	71,055
1892	30,364	43,211	73,575
1893	28,699	42,571	71,270
1894	31,156	41,626	72,782
1895	30,812	41,821	72,633
1896	29,943	43,341	73,284
1897	30,065	43,725	73,790
1898	29,745	43,690	73,705
1899	29,577	45,044	74,621

The destructor at Letts Wharf was in constant operation both day and night throughout the year, with the exception of a stoppage of 83 days for repairs and cleaning of flues.

The destructor was, therefore, at work for 282 days, including Sundays and Bank holidays when the fires are just banked up.

The number of loads of refuse destroyed was 22,481, which produced a residuum of 5,194 loads of ashes and clinkers, more or less hard but valueless and for the removal of which the Corporation had to pay.

Clerkenwell.—Have a 2-cell Baker's Destructor at their sorting depôt at Phœnix Wharf, Lambeth; mostly paper and light waste is destroyed in the cells.

Fulham.—This Vestry have contracted with the Horsfall Destructor Company to erect a 12-cell destructor.

St. George's, Hanover Square.—Part is sorted and disposed of by contract.

St. George's in the East.—Sorted, sifted, and barged away.

St. George the Martyr.—Barged away.

St. Giles in the Fields.—Disposed of by contract, sorted and barged away.

Greenwich Parish: St. Paul's, Deptford; St. Nicholas, Deptford.—Barged away.

Hackney.—A destructor is now in course of erection for this Vestry by Messrs. Hughes and Stirling.

Hammersmith.—Now barged away, but the provision of a destructor is under consideration.

Hampstead.—Here an 8-cell Fryer Destructor, erected by Messrs. Manlove, Alliott and Co., is in use ; a cremator is also provided ; each cell deals with between five and six tons per 24 hours.

Holborn.—Disposed of by contract, sifted, sorted, and barged away.

Islington.—This is said to be the most densely populated parish in the country, having a population of 112 to the acre ; the refuse is disposed of by contract and barged away. A portion of the refuse has been taken to St. Luke's Destructor to be dealt with.

Kensington.—A 2-cell destructor was erected at the Vestry Wharf by Messrs. Goddard, Massey and Warner, but it does not appear to have been in use for some time past.

During last summer at Earl's Court Exhibitiona beehive shaped structure with a very low chimney, called a refuse destructor, has been razed to the ground at the instance of the Fulham Medical Officer. It appears that for a long time a very curious and suspicious effluvia had been detected in the grounds of the Exhibition ; a search unearthed the so-called destructor, where bones, sawdust from the lions' den, and other refuse of various kinds was smouldering away.

Lambeth.—Messrs. Manlove, Alliott and Co. have recently erected a destructor here.

Lewisham and Penge.—Here a Willoughby Destructor has been erected, the only one in the country. This destructor was erected on trial and then sold for £3,000 ; according to Mr. J. Carline's report on the first three months' working, 2½ tons of refuse per hour was dealt with, the residue being 36 per cent. The cost of fuel for each ton of refuse dealt with was 1s. 8d. The total cost per ton destroyed, including fuel, was 2s. 11d., but the sale of residue reduced this to 2s. 6d. per ton.

Limehouse.—Disposed of by contract, barged away.

St. Luke's.—Messrs. Goddard, Massey, and Warner erected a 6-cell destructor for this Vestry, but according to the report of Mr. Arthur May, the Cleansing Superintendent, after some three years of somewhat interrupted working, it was decided that reconstruction must be faced. It was, therefore, decided that the work of pulling down and reconstructing the cells be given to the Horsfall Destructor Company, Limited, who erected six of their cells arranged back to back, with a charging hole common to two cells. The work was completed early last year. The furnaces occupy a space of 24 ft. × 24 ft. and 12 ft. high, with the main flue, situated in the middle, common to all six cells. Among novel features introduced with this installation is a dust catcher, and also a hydraulic lift, which is provided to raise both the horse and cart on to the tipping floor. This, of course, is instead of the usual inclined road for the top feed.

[1] According to Mr. May the actual figures of the cost of working the destructor are as follows :—Wages per week (furnace men only), £12 18s. ; foreman and one-half engineers wages, £3 5s. ; loading of clinker and disposal, £13 3s. ; estimated interest on capital, and repayment of loan for destructor only, £5 7s. ; total cost per week, £34 13s. Tons per week, 360 tons 10 cwts. ; cost per ton, burning only, 8·6d. ; cost per ton, total charges, 1s. 11·1d. Against this sum must be put the following assets :—Disposal of trade refuse (without cartage), £18 ; the amount paid for disposing of the other Vestries refuse, £9 12s. 1d. ; a good quantity of the clinker and flue dust produced is sold at prices ranging from 1s. to 4s. 6d. per ton, amounting to about, per week, £7 3s. 6d.

Marylebone.—Here the refuse undergoes a sorting and sifting process, and the worthless residue is barged away.

Mile End, Old Town.—From the copy of the Surveyor's report for the year 1898, here shown, will be seen the methods and cost of disposal. The question of providing a destructor has been before the Vestry for some time past, and a deputation has visited a number of destructors in various parts of the country; since that time a report has been issued recommending the adoption of a destructor.

VESTRY OF THE HAMLET OF MILE END OLD TOWN.

Surveyor's Report.

Disposal of House Refuse for the Year Ending March 25th, 1898.

The quantity of ashes and breeze sifted and put on rail was 10,837 tons, and 2,368 tons of rough dust was also put on rail, the whole being used for brickmaking purposes. 6,630 tons of core was loaded into barges and sent to shoot at Edmonton.

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[1] See paper read before the Association of Cleansing Superintendents in December 1899, by Mr. Arthur May, Cleansing Superintendent to the Vestry.

During the year, 9,163 tons of light rubbish were burnt in the furnaces at Devonshire Street Depot, and the residue, amounting to 1,078 tons, was disposed of on rail.

It will be satisfactory to find that the sale of ashes and breeze amounts this year to nearly £800 more than last year, but there is great difficulty in getting marketable commodity out of the material which is now coming in, and the ultimate result will be that the whole will have to be destroyed, as the cost of sifting so largely exceeds the amount received.

Cost of disposing of house refuse for the year ending March 25th, 1898 :—

1896.	£	s.	d.
Carriage and other disposal of refuse	1,198	12	5
Sifting, loading and burning	1,984	11	10
Rent of wharf and siding	160	0	0
	3,343	4	3
Less amount received and receivable for sale of ashes, breeze and clinkers	371	17	2
	£2,971	7	1

1897.	£	s.	d.
Carriage and other disposal of refuse	1,011	11	9
Sifting, loading and burning	2,389	1	7
Rent of wharf and siding	160	0	0
	3,560	13	4
Less amount received and receivable for sale of ashes, breeze and clinkers	580	14	6
	£2,979	18	10

1898.	£	s.	d.
Carriage and other disposal of refuse	828	12	11
Sifting, loading and burning	2,499	3	1
Rent of wharf and siding	160	0	0
	3,487	16	0
Less amount received and receivable for sale of ashes, breeze and clinkers	1,471	14	6
	£2,016	1	6

DISPOSAL OF STREET REFUSE.

	£	s.	d.
Use of shoots	305	11	0
3,991 tons were sent to farmers for manure at a cost of... ...	196	16	9
	£502	7	9

Paddington.—Disposed of by contract, sorted, sifted, and sold.

St. Pancras.—Here Messrs. Goddard, Massey, and Warner erected an 18-cell destructor. Forced draught is provided by Sturtevant Blowers; each cell is said to deal with about 7½ tons per day.

Plumstead.—Charlton Parish, Lee and Kidbrook Parish, Plumstead Parish.—Here it has been customary to tip the refuse on some low-lying land near the riverside, but tenders have recently been invited for the erection of a 12-cell destructor to work in connection with the Electricity Works. This contract has since been awarded to Messrs. Meldrum Brothers, Limited, for one of their 3 four-grate unit Simplex destructors, together with 3 Babcock and Wilcox boilers with 1,827 square feet of heating surface each.

The maximum capacity of this plant will be about 180 tons per 24 hours, but as the immediate quantity of refuse to be dealt with is only 60 tons per day, one unit and boiler can always be standing for flue cleaning, etc. In addition to being the first destructor of the type in London it will be unique in several ways, a chimney only 80 feet in height will be provided, an entirely new departure for a large plant such as this.

The whole of the available power will be used for electric lighting. Large motor vans will be employed for collection of the refuse, and both the destructor and electricity works will be equipped in a thoroughly up-to-date manner. The whole scheme has been prepared by, and will be carried through under the supervision of, Mr. Frank Sumner, A.M.I.C.E., the Borough Surveyor, and Mr. J. B. Mitchell, the Borough Electrical Engineer.

Poplar.—Messrs. Goddard, Massey, and Warner erected a 12-cell destructor here, and a 50 horse power boiler in connection.

Rotherhithe.—Here the Vestry have erected a 2-cell Beaman and Deas Destructor, with two Babcock and Wilcox Boilers, each 64 horse-power, in connection. Each cell will comfortably deal with 15 tons per 24 hours.

Shoreditch.—This plant has been too often described to call for any lengthy description in this work. To briefly describe same, the installation comprises 10 cells, built by Messrs. Manlove, Alliott, and Company, Limited, together with five Babcock and Wilcox Boilers. The general arrangement of cells and boilers has been aptly termed "sandwiching," that is, one boiler is set between two cells.

Each boiler is provided with an ordinary grate, hand-fired in the usual way, so that when it is found necessary coal can also be used direct on to the grate under the boiler.

The refuse is shot from the carts into electric hoists, which work in connection with Boulnois and Brodie's patent charging arrangement which is used for feeding the cells. Here will be found figures of some tests made with the whole plant, and also other data, which will be found interesting, although not so complete as might be said to be desirable :—

EVAPORATIVE TESTS AT SHOREDITCH DESTRUCTOR AND ELECTRICITY WORKS.

TEST NO. I.—DURATION FIVE HOURS, 8 A.M. TO 1 P.M.

January 10th, 1899.

Total water evaporated from and at 212° Fahr.	72,220 lbs.
Total refuse burned	75,092 lbs.
Refuse burned per hour	15,018·4 lbs.
Refuse burned per cell per hour	1,501 lbs.=13cwts. 1qr .17lb.
Number of cells in use	10
Number of boilers in use	5
Water evaporated per hour	14,445 lbs.
Water evaporated per boiler per hour ...	2,889 lbs.
I.H.P. per boiler per hour, taking 20 lbs. steam per I.H.P. per hour	144 I.H.P.
Water evaporated per lb. of refuse burned from and at 212° Fahr.	0·96 lbs.

TEST NO. II—DURATION FIVE HOURS, 3 P.M. TO 8 P.M.

Total water evaporated	108,319 lbs.
Water evaporated per hour	21,663·8 lbs.
Number of cells in use	10

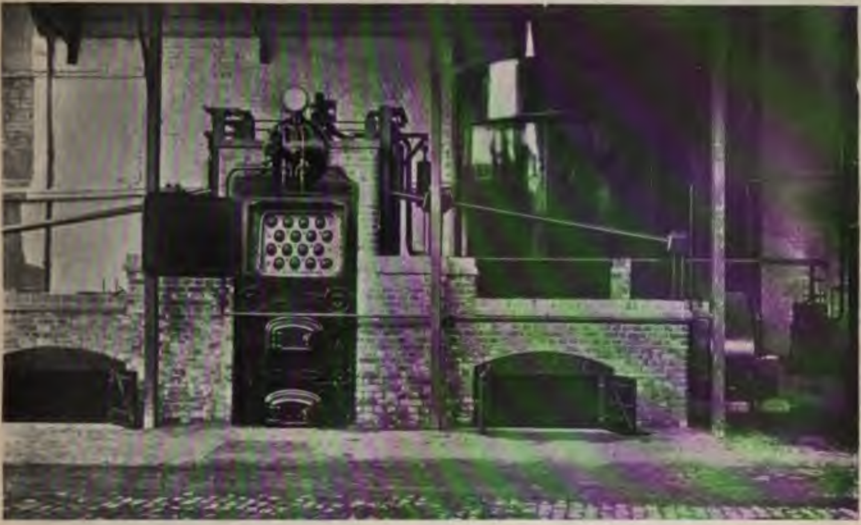

FIG. 11.—BAKER'S IMPROVED DESTRUCTOR AT CLERKENWELL VESTRY DEPOT, PHŒNIX WHARF, LAMBETH.

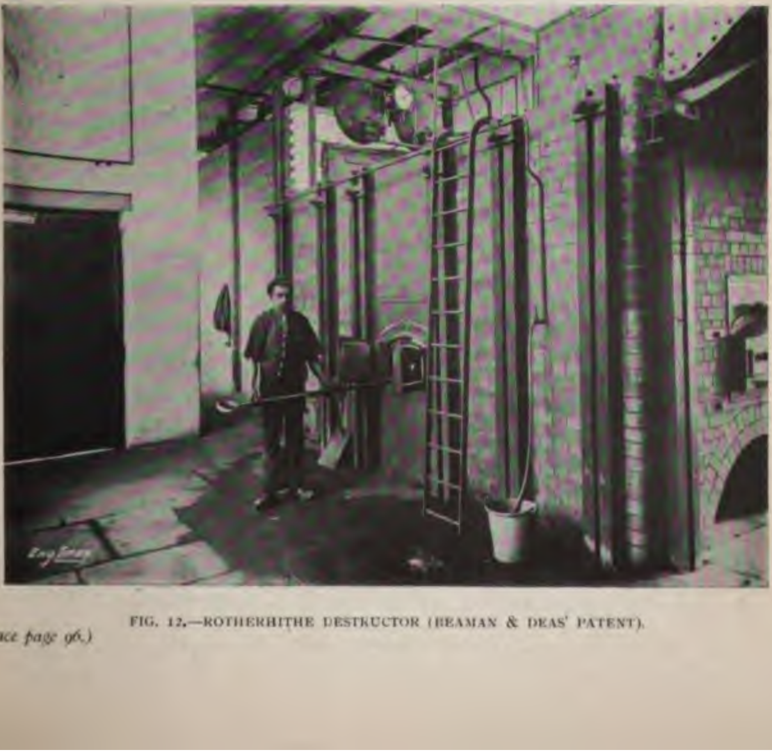

FIG. 12.—ROTHERHITHE DESTRUCTOR (BEAMAN & DEAS' PATENT).

(To face page 96.)

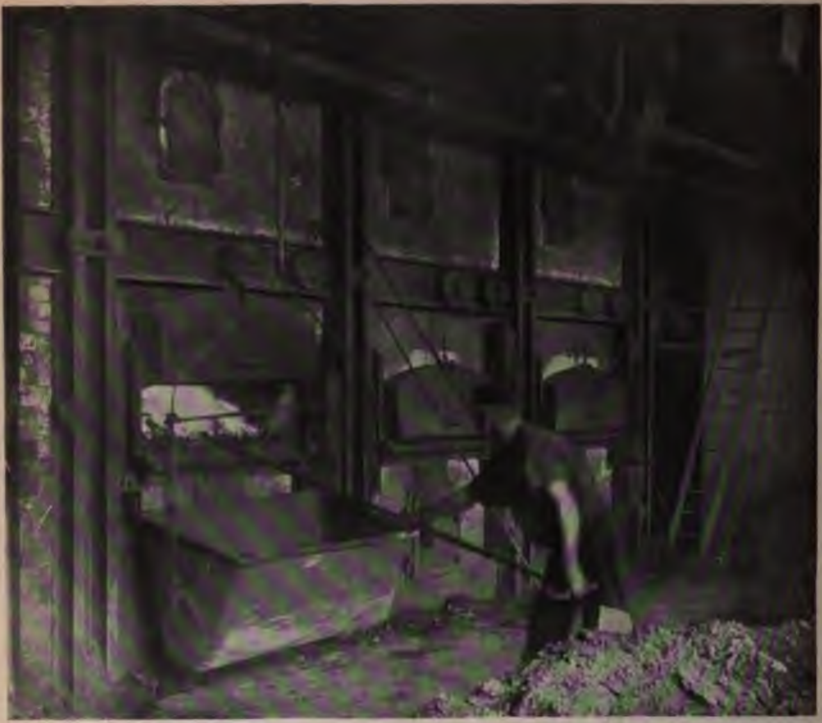

FIG. 13.—HORSFALL'S DESTRUCTOR AT HAMMERTON STREET, BRADFORD, SHOWING CLINKERING PROCESS.

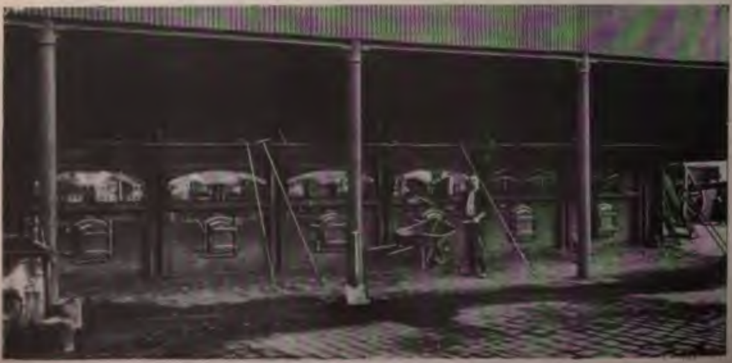

FIG. 14.—HORSFALL'S PATENT DESTRUCTOR AT RHODES BANK, OLDHAM.

Total refuse burned	60,700 lbs.
Refuse burned per hour	12,140 lbs.
Refuse burned per cell per hour... ...	1,214 lbs.=10 cwts. 3 qr. 10 lb.
Total Welsh coal used (Powell Duffryn) ...	6,272 lbs.
Number of boilers in use	5
Coal fired per hour	1,254·4 lbs.
Coal fired per boiler per hour	250·9 lbs.

ANALYSIS OF REFUSE FOR YEAR ENDING JUNE, 1898.

	Tons.	Cwts.	Qrs.	Lbs.
Domestic refuse	23,137	5	0	0
Trade refuse—straw, paper, tan, market refuse, etc., ...	2,257	9	2	14
Wood chips, about	10	0	0	0
	25,404	14	2	14

The average percentage of moisture is said to be 20 per cent.

ANALYSIS OF COSTS OF REFUSE DESTRUCTION, YEAR ENDING JUNE 30TH, 1898.

	s.	d.
Total quantity of refuse destroyed	25,404 tons	
Cost per ton for actual burning, including four furnace men, three top men, and 1 foreman	1	5·98
Ditto supervision and clerical staff	0	2·50
Cleaners and yardmen	0	6·23
Repairs	0	0·45
Stores, etc.	0	1·23
	2	4·39

YEAR ENDING MARCH 25TH, 1899.

	s.	d.
Total amount of refuse destroyed	26,201 tons.	
Cost of burning	1	10·20
Cost of supervision, etc.	0	1·86
Cost of cleaners and yardmen...	0	3·27
[1] Cost of repairs	0	1·50
Cost of stores and sundries	0	2·07
	[illegible]	

[illegible] burned for repairs gives a total of £163 15

ELECTRIC ENERGY ABSORBED IN ONE YEAR IN THE BURNING AND HANDLING OF REFUSE.

	Units per Ton.
Electric fans	4·0
Electric fans, total units used	84,804 units B.T.U.
Electric lifts and tipping trucks	0·5
Total units used by Destructor	131,140 units B.T.U.
Total energy metered out to consumers including 131,140 B.T.U. supplied to refuse destructor	1,031,348 units
Coal consumed (value £1,308 14*s.* 8*d.*) ...	1,344 tons.
Refuse burned	26,201 tons.

It is of considerable interest to look into comparative figures of refuse and coal used during the year ending March 25th, 1899.

Firstly, 1,344 tons equal 3,010,560 pounds of Welsh coal, this should, under good conditions, evaporate ten pounds of water per pound of fuel, equal 30,105,600 pounds of water evaporated.

Secondly, if we take the refuse consumed during the same period—26,201 tons equal 58,690,240 pounds, and if, for purposes of argument, we allow an evaporation of one pound of water per pound of refuse, we have the following very significant comparative figures :—

	Lbs. of Water Evaporated.
26,201 tons of refuse equal	58,690,240
1,344 tons of Welsh coal	30,105,600

Thus one year's coal consumpt, burned under good conditions, would give more than half as much steam as a year's supply of refuse, even assuming an average evaporation of one pound of water per pound of refuse.

St. Saviour.—Disposed of by contract, barged away.

St. Olaves.—Disposed of by contract, barged away.

Strand.—Here a 6-cell Horsfall Destructor has been erected.

Wandsworth : Clapham Parish, Streatham Parish, Tooting Parish, Putney Parish, Wandsworth.—Here a 4-cell destructor of the Beaman and Deas type has been erected with Babcock and Wilcox boilers of 150 horse power. Each cell deals with about 18 tons per 24 hours.

Westminster : St. James, St. Margaret, St. John.—Disposed of by contract, barged away.

St. Martin in the Fields.—Disposed of by contract, barged away.

Whitechapel.—Here is a destructor of the Fryer type, erected by Messrs. Manlove, Alliott, and Company. The first cells were erected in 1886, and extensions have been made since, the last quite recently.

Woolwich.—A 6-cell destructor of the Fryer type was erected in 1893 by Messrs. Manlove, Alliott, and Company.

In Colonel Codrington's report to the Local Government Board in 1888, he gave the following analysis of London refuse.

	Per cent.
Ashes	52·6
Breeze (cinders)	28·8
Soft core (animal and vegetable refuse)	14·2
Hard core (broken pottery, &c.)	2·9
Coal	0·15
Bones	0·25
Rags	0·425
Old iron	0·35
Old metals	0·025
White glass	0·075
Black glass	0·225
	100·000

LONDON ASH BIN REFUSE.

The following analyses are taken from a paper read by Mr. Jos. Russell before the Sanitary Institute on February 10th, 1892.

Component Parts.	Average per 1,000 loads.				Per cent. By weight.
	Tons	cwts.	qrs.	lbs.	
Breeze (cinders and ashes)	611	3	0	4	63·69
Fine dust	187	1	0	8	19·51
Vegetable, animal and various mineral matters	44	3	3	20	4·61
Waste paper	41	1	1	20	4·28
Straw and fibrous material	30	18	1	6	3·22
Bottles (5,000)					0·96
Coal and coke	8	0	2	14	0·84
Tins	7	11	2	22	0·79
Crockery	5	5	0	0	0·55
Bones	4	12	1	1	0·48
Broken Glass	4	11	2	2	0·47
Rags	3	15	3	16	0·39
Iron	2	0	0	20	0·21
					100·00

See London County Council report dated May 10th, 1893.

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CHAPTER XI.

REFUSE DISPOSAL IN THE GREAT TOWNS OF ENGLAND AND WALES.[1]

BIRKENHEAD (population 110,631).—Here are two installations, each of 12-cells; the first was of the Fryer type, and was put down in 1896. The more recent plant is by Messrs. Goddard, Massey and Warner. Each cell deals with about seven tons per 24 hours; cost of disposal 10·21d. per ton, not including cartage to the depôts.

BIRMINGHAM (population 510,343).—The first cells were erected in 1877 by Messrs. Manlove, Alliott and Company. Since then several extensions have been made, and at the present time over 50 cells are in use. Six tons are consumed per cell per 24 hours. The greater part of the available steam is used for the steam-jacketed dryers. The pan system still largely prevails in this city, the pans being collected periodically at night, and the fæcal matter is converted into a concentrated manure or poudrette, for which there is a ready sale. Notwithstanding the large number of cells in use in Birmingham, a very large quantity of refuse is still being tipped, as will be seen from the following table.

Total quantity of refuse collected during the year, 1897, disposed of as follows :—

	Tons.
Refuse sent to tips, principally barged ...	34,703
Refuse dealt with by destructor	96,309
Mixed manure, ashpit manure, fish, sweepings, sent to tips by boat, to fields by cart, or sent away by rail to order	74,855
Brickbats sent to tips	416
Material sold, comprising :—	
Oyster shells	15
Glass	19
Scrap tin	296
	206,703 tons

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[1] So called by the Registrar General—thirty-two in number—generally speaking they are cities and towns with populations exceeding 100,000; it will be understood that all are county boroughs.

Blackburn (population 133,000).—Messrs. Manlove, Alliott and Company erected eight Fryer cells in 1897, and extended in 1890. Six tons per cell per day are consumed; cost of destruction 10d. per ton. A fume cremator is used, with coke as fuel; this adds 2½d. per ton to the cost of refuse disposal. Messrs. Meldrum Bros., Limited, erected two cells early this year, which are reported to be doing very satisfactory work. The Corporation have also recently decided to install some Heenan Twin Cells, made by Messrs. Heenan and Froude, Limited, of Farnworth.

Bolton (population 161,376).—Here are two installations at present. Messrs. Manlove and Company put in the first of eight cells in 1881, in 1897 ten additional cells were erected, chiefly of the Corporation's own design. The cost of destruction appears to be 8½d. per ton for labour. Messrs. Meldrum Bros., Limited, now have in hand 8-cells Beaman and Deas' patent for the Corporation, to be erected at the Sewage Pumping Station, to deal with pressed sewage sludge as well as refuse.

Bradford (population 235,000).—The destructors here were erected by Messrs. Manlove, Alliott and Company in 1880, and have been considerably extended since. There are now four installations as follows:—Hammerton-street, 12 cells; Sunbridge-road, 9 cells; Cliffe-lane, 8 cells; Southfield-lane, 8 cells. At Hammerton-street the 12 cells are of the Horsfall type, 9·13 tons per cell per day are consumed; at the other three installations all the cells have Horsfall's Forced Draught applied. The Corporation have recently contracted with the Horsfall Destructor Company to erect some additional destructors.

Test of the Horsfall Destructor at Bradford, October 18th to 23rd, 1897.

Number of cells	Six
Type of cells	Back to back
Duration of test	141 hours
Nature of fuel	Unscreened midden and market refuse
Number of men employed, including boiler attendant	Seven

Wages	4s. 8d. per day
Total quantity of refuse burned	721,280 lbs.=322 tons
Total quantity of refuse burned per cell per 24 hours	20,462 lbs.=9·13 tons
Total quantity of refuse burned per cell per hour	852·6
Total weight of water evaporated	523,000 lbs.
Total weight of water evaporated per hour	3,709 lbs.
Total weight of water evaporated per cell per hour	618 lbs.
Water evaporated per pound of refuse burned	·725 lbs.
Weight of clinker produced	205,460 lbs=91·72 tons
Weight of fine ash produced	13,401 lbs.=6 tons
Total weight of residuals	218,861 lbs=97·23 tons.
Percentage of residuals	30·3 per cent.
Steam pressure maintained, by recorder	60 lbs.
Temperature of feed water	50° Fahr.
Temperature of gases in main flue	1,800° Fahr.
Temperature of gases at chimney bottom	900° Fahr.
Average air pressure (water gauge)	⅝″
Total indicated horse power per hour (at 20 lbs.)	185·45
Total indicated horse power per cell continuously	30·91
Indicated horse power hours per ton burned	81·
Steam used for jets.	
Duration of test	6 hours
Total water evaporated	1,400 lbs.
Total water evaporated per hour	2,333·3 lbs.
Total water evaporated per cell	388·8 lbs.

BRIGHTON (population 120,490).—Twelve Fryer cells are installed here, and also Boulnois and Brodie's patent charging apparatus. Seven tons per cell per 24 hours is consumed. A 30 horse power boiler was set with these cells in 1896, the steam from same being used for driving mortar mills and stone breaking machinery.

Bristol (population 318,042).—In 1892 16 Fryer Cells were erected, steam forced draught was applied to eight cells. Each cell consumes 7¼ tons per 24 hours.

Burnley (population 102,860).—For many years one of the old "Beehive" Destructors was used here, but although it did very well in its day this type is now quite obsolete. In 1898 a 2-cell Beaman and Deas Patent Destructor was erected, and this is said to have done very satisfactory work indeed. Each cell consumes 15 tons per day.

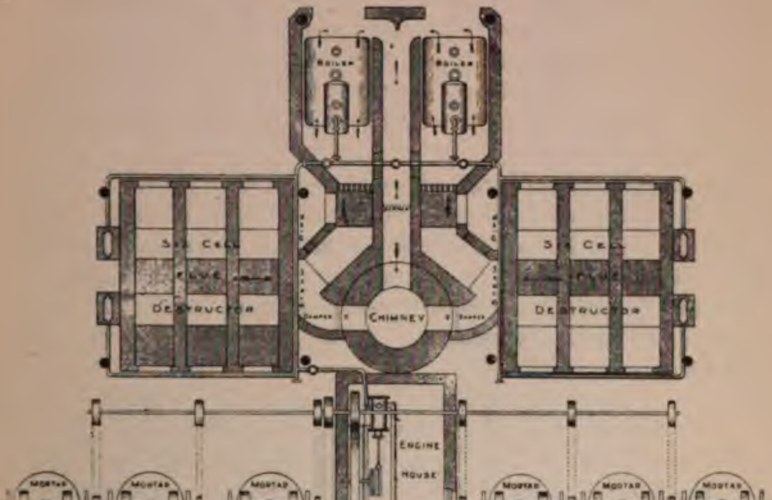

FIG. 15.—SECTIONAL PLAN OF HAMMERTON STREET DESTRUCTOR, BRADFORD.

Cardiff (population 177,000).—The question of erecting destructors has been before the Council here for the past three years; it is expected that a decision will now be arrived at very shortly.

Croydon (population 124,120).—The refuse is at present partly tipped and partly sold. The Council have had the erection of a destructor under consideration for a long time past.

Derby (population 101,770).—In 1882 six Fryer Cells were erected, and in 1898 Messrs. Goddard, Massey and Warner erected six cells; each cell deals with seven tons per 24 hours.

Gateshead (population 100,311).—No destructor has yet been erected here, but a crude furnace is used for burning a small portion of selected dry refuse, and any condemned bedding, etc.

Halifax (population 99,000).—Destructors have not yet been adopted here, but the question is now before the Council.

Huddersfield (population 102,454).—Messrs. Manlove, Alliott and Company erected a 10-cell Fryer Destructor in 1891. Each cell consumes six tons per 24 hours; the cost of burning is 10½d. per ton. A fume cremator is used with coke as fuel. Two cells of the Horsfall type have been erected at the Deighton Sewage Works, dealing with a quantity of sludge.

Hull (population 229,887).—In 1882 six Fryer Cells were erected; these were worked with natural draught until 1898, when Horsfall's Forced Draught was added. Recently Messrs. Horsfall have received instructions to erect 12 additional cells.

Leeds (population 416,618).—The city of Leeds has four Destructor Works, comprising in all 50 cells made up as follows:—

Depot.	No. of Cells.	Date erected.	Type.
Burmantoft's ...	6	1876	Fryer's, but with
Burmantofts ...	4	1883	Horsfall's Forced
Burmantofts ...	4	1887	Draught added
Armley Road ...	6	1877	"
Armley Road ...	4	1884	"
Armley Road ...	2	1886	"
Armley Road ...	4	1894	Horsfall type
Kidacre Street ...	10	1891	" "
Kidacre Street ...	2	1894	" "
Meanwood Road...	8	1895	" "

The quantity consumed per cell varies from 6·7 tons per 24 hours at Kidacre Street, to over 7 tons at Meanwood Road Depot. The cost of labour per ton burned varies from 6·9 to 13·46d., the cost per ton going up considerably when the higher quantity per cell per day is being consumed.

It is said that the destructors here have been supplied with the following miscellaneous collection in one year, in addition to the usual refuse :—11 cows, 3 calves, 17 sheep, 4 goats, 298 pigs, 5 turkeys, 2 carcases of beef, 28 quarters of beef, 9 cwts. pickled tongues, 12 cwts. herrings, 218 cwts. shell fish, 1 cwt. sugar, 285 dogs, 109 cats, 13 foxes, 1 sea serpent, 147 mattresses, 7 blankets, 36 carpets, 7 hearth rugs, beds, pillows, and bolsters.

Leicester (population 208,662).—Here are three Destructor Works. The first installation was made in 1890, and comprised six Fryer Cells at Needham Street ; in connection with these, three Multitubular Boilers have been put down. Steam power is supplied to an engineering works adjoining to the extent of 40 indicated horse power, at the rate of £3 15s. per horse power per annum, but complaints have been made that the supply of steam is very intermittent and unsatisfactory.

In 1893 six cells, designed by the Borough Engineer, were erected at Mill Lane, and in the following year another similar installation was made at Lero Street. The cost for labour per ton of refuse burned is given at 8·2d.

Messrs. Manlove, Alliott and Company, Limited, now have a contract in hand for a 6-cell destructor to be erected in the Humberstone and Evington district. The contract price is £6,755 19s. od.

Liverpool (population 668,645).—About 44 cells are now working here, distributed as follows:—Charters Street, 24 cells ; the first 12 were erected in 1891, the remainder in 1893. Rathbone Road, six cells erected in 1893 ; and Toxteth Park, eight cells, while another six have recently been added. In connection with this last extension, a Stirling Water-Tube Boiler was put down, the first boiler of this type to be used in connection with destructors in the Kingdom.

All the cells are of the Fryer type, and with most of them Boulnois and Brodie's patent charging apparatus is in use.

[1]About seven tons per cell per 24 hours is destroyed. Some complaints of nuisance have been made by residents in the neighbourhood of the Toxteth Park destructor, and prosecution has been threatened, but as yet no action has been taken.

Mr. W. Harpur, M.I.C.E., Borough Surveyor, Cardiff, in his report on the Liverpool installations, dated December, 1896, says :—" The bulk of the refuse is sent to sea in steam hoppers, of which there are two. Each hopper makes an average of four journeys per week, and carries about 450 tons of refuse per journey, which is deposited in the Irish Sea, about 24 miles from St. George's Pier, Liverpool. It is found that in severe weather the hoppers cannot go to sea sometimes for several days together, resulting in large accumulations of refuse on the dock wharf, which is afterwards very difficult to get rid of.

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[1] With the earlier installations.

"The working expenses of each hopper is about £30 per week. The Corporation are contemplating discontinuing sending anything but burnt refuse from the destructors to sea, owing to complaints that the lighter kinds of refuse are washed up on the Welsh Coast."

MANCHESTER (population 539,079).—Special interest attaches to this city, because here the first destructor built on scientific principles was erected. Ordinary furnaces of a very crude design were adopted over 30 years ago, but it was not until 1876 that the Corporation decided to introduce some Fryer Cells.

There are now four large refuse depots in Manchester, and destructor installations have been installed at three of the depots. Four Fryer Cells were erected in 1876 at Water Street, and at that time such satisfactory work was done that many Corporations throughout the country soon decided to instal a similar plant.

A few years later these furnaces were enlarged and remodelled by the late Mr. Henry Whiley, who was then Superintendent of Cleansing, etc. He also introduced a system of treating refuse at the Holt Town and Newton Heath depots.

Mr. Whiley's Destructor, as erected at the depots in Manchester, has certainly been very successful. However, at Huddersfield the results with the same type were not at all successful.

A number of Lancashire and Galloway Boilers have been put down at the depots for burning refuse directly on the grates. These have been in use for a number of years, with very satisfactory results.

At Holt Town Works some £50,000 has been spent in machinery for dealing with the various kinds of refuse. There are large desiccating machines for treating excreta collected from the pail closets, and the concentrated manure produced is sold for £3 per ton. There are also means for treating dead animals and producing soap, tallow, and candles from the fats extracted. Paper has also been manufactured from old rags, and oxide paint from old tins and iron, after taking away the solder in a specially designed furnace.

The destructors in Manchester, like those in the big rival city of Liverpool, are altogether inadequate to deal with the immense production of refuse, so that some 70,000 tons per year have to be tipped.

Recently, Messrs. Meldrum Brothers, Limited, have altered one of the Whiley Cells to give an increase of 50 per cent. in duty. This is as an experiment, and preliminary to the alteration of 17 cells.

Colonel Codrington gives the average composition of Manchester refuse as follows :—

	Per cent.
Ashes and excreta in pails	64·5
Dust and cinders...	34·55
Fish and bones	0·15
Dogs, cats, hens, rabbits, etc.	0·05
Boots, rags, hats, paper, etc.	0·05
Vegetable refuse	0·05
Glass, pottery, bricks, etc.	0·60
Old iron and tin ware	0·05

NEWCASTLE-ON-TYNE (population 223,021).—Twenty years ago a small furnace was erected in this city for burning paper and other light inflammable waste, but it was not until 1885 that they commenced to deal with the refuse on more scientific principles by erecting six Fryer Cells.

In 1890 six cells were also erected by Messrs. Goddard, Massey and Warner, upon the working of which Mr. W. G. Laws, the City Engineer, reports very favourably indeed.

The whole inclusive cost of burning is given at one shilling per ton.

In a recent report to the Town Improvement Committee, Mr. W. G. Laws, the City Engineer, remarks "that the disposal of refuse is becoming increasingly difficult, and that it may presently be deemed advisable to build another destructor." There is, however, a strong feeling in the city that as the existing cells are only dealing with a very small quantity per cell per day, they might be so altered as to deal with a greatly increased quantity. While this remains undone, a section of the Council are likely to offer strenuous opposition to the erection of another destructor.

NORWICH (population 100,964).—Here a 2-cell Horsfall Destructor was erected three years ago, at the New Mills Pumping Station of the Corporation. A Babcock and Wilcox Boiler, 80 horse power, with 735 square feet of heating, is used in connection with the cells for supplying steam for driving air compressors for Shone's Ejectors.

During the official test by the City Engineer, each cell consumed 15 tons per 24 hours, with a total evaporation of 2,400 lbs. of water per hour.

NOTTINGHAM (population 236,000).—In 1882 five Fryer Cells were erected. Horsfall's Forced Draught was added to four of the cells in 1893. Each cell consumes about seven tons per day; a Multitubular Boiler is used with the cells, and the steam generated drives an engine of 25 horse power. Additional cells are under consideration, the present destructor being inadequate.

[1] "A councillor on Monday moved the adoption of a report of the Health Committee recommending the erection of a refuse destructor, at the Eastcroft, at a cost of about £21,000, and one at Radford at a cost of about £10,000. The speaker said that, at the present, they had a 5-cell destructor, which was able to deal with 7,500 tons, leaving 15,500 tons to be dealt with. The cost was something like 3s. 8d. per ton, but the new destructors would reduce the cost to about 8d. or 9½d. per ton. There would, therefore, be a saving of about 3s. per ton on about 7,000 tons. The 5-cell destructor required 14 men, while a 12-cell destructor, working 24 hours, would only require 24 men—six for each shift. They anticipated that by utilising the heat which was generated by the cells, they would have from 450 to 500 horse power of continuous steam in the 24 hours. That they intended to utilise for the production of electricity, either for driving the tramways in the southern division or for lighting purposes. The value of the steam to the Electrical Committee would be something like £4,000 per year. The report was adopted."

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[1] See the *Surveyor*, September 22nd, 1900.

Oldham (population 148,288).—Ten cells of the Horsfall type are working here at the Rhodes Bank Depôt. Eight tons per cell per day are burned at a cost of 9¾d. per ton for labour.

Reference is made to this installation in other chapters. Particulars of tests made are here given.

TEST AT RHODES BANK DESTRUCTOR, OLDHAM, MAY 5TH AND 6TH, 1898. DURATION 24 HOURS.

Number of cells in use	10 = 1,4 cell battery 1,6 " "
Refuse consumed per cell, per 24 hours ...	7·96 tons
Total refuse consumed	79·6 tons
Total residue in pounds	56,690 = 26·2 tons
Total percentage of residue to refuse burned	32·9 per cent.
Average pressure in boilers per square inch ...	128 lbs.
Average temperature of feed water	57° Fahr.
Total water evaporated in pounds	157,000
Total water evaporated equivalent from and at 212° Fahr.	189,200 lbs.
Equivalent evaporation per cell, per 24 hours	18,900 lbs.
Average equivalent evaporation per lb. of refuse, from and at 212° Fahr.	1·06 lbs.
Temperature of gases before passing through economiser	700° Fahr.
Temperature of gases after passing through economiser	555° Fahr.
Average draught in ashpit in inches of water	1⅛"

Plymouth (population 100,000 estimated).—The Corporation have contracted with Messrs. Goddard, Massey and Warner to erect 10 of their Warner Perfectus Cells.

Portsmouth (population 160,000).—Here the refuse is still tipped on waste land; the question of erecting a destructor has been before the Council for a long time, but no progress has been made; and, although over 120 tons of refuse per day is produced, yet this important town would appear to be no nearer the erection of destruct[illegible] was the case 50 years ago.

Much indignation has been [illegible] continued nuisance caused by the tipping of th[illegible]rence is made in this in the chapter dealing wi[illegible]

Preston (population 116,358).—Twenty-eight Fryer Cells have been erected here for many years past, 18 of which are in regular use. Six tons per cell per day are consumed at a cost of 10d. per ton for labour only.

Salford (population 215,702).—A 6-cell Fryer Destructor was erected in 1882, and was operated until early in 1896, when the cells were altered to the design of the late Mr. C. E. Hall, M.I.M.E., Superintendent of Cleansing.

Some 18 other cells are also working, designed by Mr. Hall, who claims that his cells will burn 20 per cent. more than Fryer's. The average cost of burning each ton of refuse is 9d. per ton for furnace men's wages only.

At the main works provision is made for the housing of stray dogs, which, if not claimed within reasonable time, are caged, drowned in the canal, and then cremated in the cells.

Recently tenders have been invited for a 2 or 3-cell destructor to be erected in connection with an existing Lancashire Boiler, and also a 6-cell destructor at Carey Street depôt. In each case a guarantee as to steam raising is asked.

Sheffield (population 356,478).—Messrs. Goddard, Massey and Warner erected six cells here about four years ago to burn 10 tons per cell per day.

GODDARD, MASSEY AND WARNER, LIMITED, LUMLEY-STREET DESTRUCTOR, SHEFFIELD.

Statement from March 25th, 1899, to March 25th, 1900 :—

Number of cells	Six with the exception of one for six days
Number of hours worked ...	7,336
Total number of loads cremated ...	16,610
Total weight ditto (in tons) ...	16,750
Tons of refuse burned per cell per day of 24 hours	9⅛ tons
Loads ditto, ditto, ditto	9 tons
Total weight of clinker residuum...	4,247 tons
Per cent. ditto...	25½ tons
Cost per ton cremating refuse, including clerks and foreman ...	1s. 2¾d.

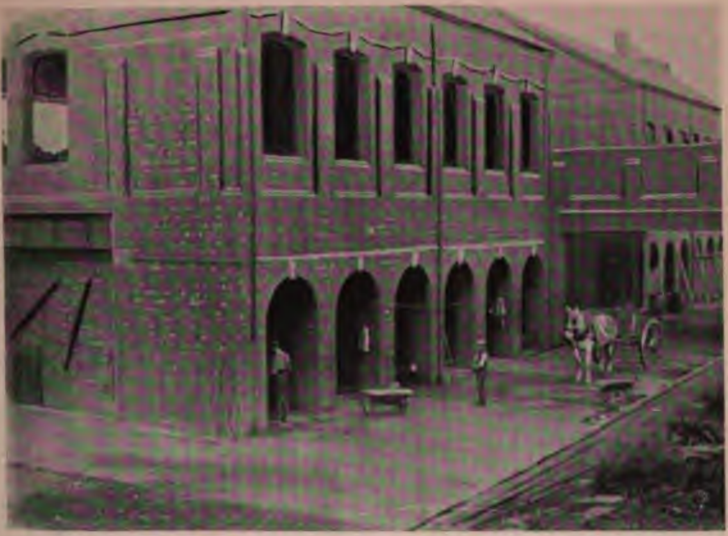


FIG. 16.—LUMLEY STREET DESTRUCTOR, SHEFFIELD; SIX WARNER "PERFECTUS" CELLS.

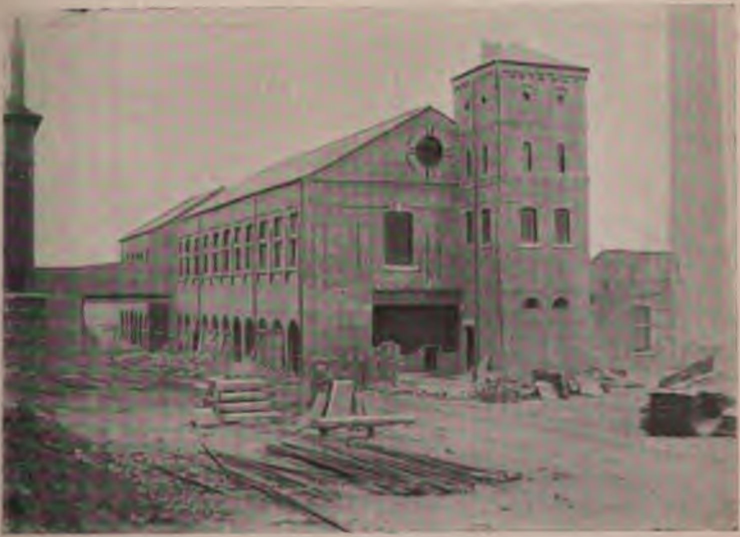


FIG. 17.—LUMLEY STREET DESTRUCTOR, SHEFFIELD. TEN ADDITIONAL WARNER "PERFECTUS" CELLS IN COURSE OF ERECTION.

(*To face page 110.*)

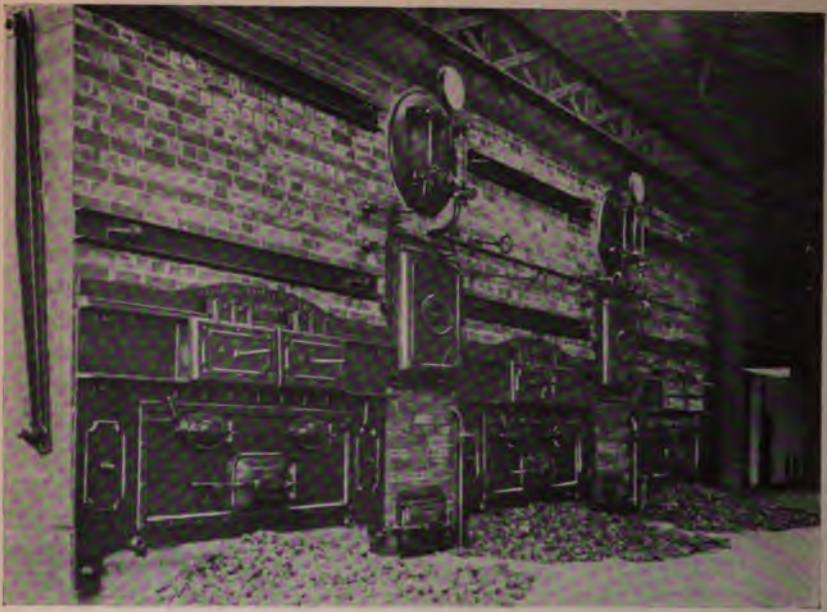


FIG. 18.—WARNER'S "PERFECTUS" DESTRUCTOR AT BURY, LANCASHIRE.

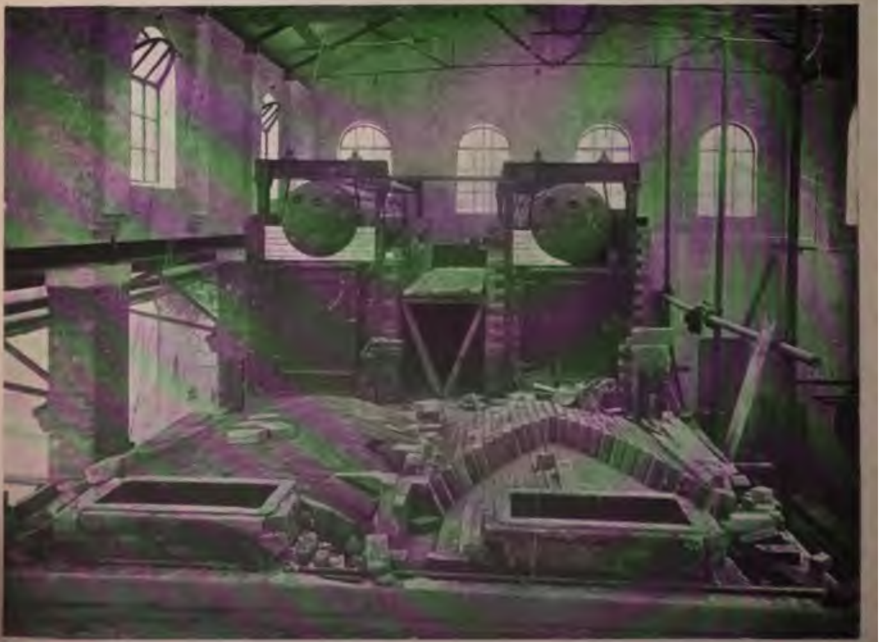


FIG. 19.—THE BEAMAN & DEAS DESTRUCTOR IN COURSE OF ERECTION AT ST. HELENS.

Cost per load cremating refuse, including clerks and foreman ...	1s. 2¾d.
Ditto ton, stokers and chargers wages only	8½d.
Ditto load ditto, ditto	8¾d.

NOTE.—Included in the above cremation were :—815 mattresses, 53 beds, 11 pillows, 15 dogs, 7 pigs, 1 ton rabbits, 1 ton 4 cwt. German yeast, 378 tons 14 cwt. fish.

SUNDERLAND (population 143,849).—Destructors have not yet been erected here, but the Council are considering the adoption of same at present. It is said that their 80,000 tons of refuse and contents of privy middens cost £12,000 per annum to remove.

SWANSEA (population 100,000).—Up to the present the refuse is tipped ; the question of erecting destructors has been before the Council for three years past, but no decision has yet been come to.

WEST HAM (population 286,654).—The erection of destructors is now under consideration, and will no doubt be seriously taken in hand after the several works now in hand are completed.

WOLVERHAMPTON (population 92,000).—The best of the refuse is sent with night soil and dry ashes in canal boats to farmers ; unsuitable refuse is carted to tips.

A deputation have recently visited a number of destructor installations, and an exhaustive report has been prepared and presented to the Council, strongly recommending the adoption of a destructor, and that the power be used for electrical purposes.

CHAPTER XII.

PROGRESS IN REFUSE DESTRUCTION IN COUNTY BOROUGHS.

BARROW-IN-FURNESS (55,570).—Have recently contracted with Messrs. Meldrum Bros., Limited, for their Simplex Patent Destructor—eight cells. The refuse has been tipped and given away to farmers, the expense involved in handling being very considerable.

BATH (52,600).—In 1895 Messrs. Goddard, Massey and Warner erected eight cells of their Warner Perfectus type. The consumption per cell is about five tons per day.

Complaints have been made recently as to offensive smells from this destructor, and at a recent meeting of the Council it was decided to ask the makers to arrange for the nuisance to come to an end.

BOOTLE (53,544).—A 12-cell destructor of the Leeds type has been in use here for some years past; owing to the arrangement for the collection of the refuse, the destructor is worked rather intermittently. The cost per ton destroyed is given at 10·6d. for labour and materials only.

BURY (60,000).—In 1879 four Fryer Cells were erected; these were used until 1897, when they were replaced by six cells of the Warner Perfectus type. Recently the corporation have contracted with the Horsfall Company, Limited, to erect six cells.

EVAPORATION TEST AT BURY WITH WARNER'S "PERFECTUS" DESTRUCTOR, BY MR. WATSON, ELECTRICAL ENGINEER.

Duration of test	4 hours
Number of cells in use	6
Total refuse consumed in four hours...	9 tons 1 cwt.
Evaporation per hour	2,700 lbs.
Temperature of feed water... ...	50° Fahr.
Evaporation per lb. of refuse ...	·532

On a basis of 20 lbs. of steam per indicated horse power per hour, each cell gave	22·5 indicated horse power per hour
Temperature	1,350° Fahr.

CANTERBURY (23,026).—Only a year ago a Beaman and Deas Patent Destructor was erected here in connection with Babcock and Wilcox Boilers, to supplement the steam supply to the Electric Lighting Station.

The cells were each to have a capacity of over 15 tons per day. That they are able to do very much more than this will be seen from the figures of the official test here shown. It will be noticed also that the evaporation is remarkably good.

RESULT OF OFFICIAL TEST CARRIED OUT AT CANTERBURY DESTRUCTOR AND ELECTRICITY WORKS WITH THE BEAMAN AND DEAS PATENT DESTRUCTOR.

(Robert Hammond, Esq., M.I.C.E., M.I.E.E., Consulting Engineer.)

Two cells in use with a total of 50 square feet of grate, with one Babcock and Wilcox Boiler with 1,619 square feet of heating surface.

Quality of refuse...	Dry, and of average quality
Duration of test...	8¾ hours
Average temperature of feed ...	123° Fahr.
Average boiler pressure	135 lbs.
Refuse consumed	29,400 lbs.
Water evaporated	41,280 lbs.
Ditto per pound of refuse under actual conditions	1·4 lbs.
Ditto from and at 212° Fahr. ...	1·58 lbs.
Ditto temperature of feed water at 60° Fahr.	1·28 lbs.
Refuse burnt per hour	3,360 lbs.
Refuse burned per hour per square foot of grate	67·5 lbs.

Water evaporated per hour average	4,717 lbs.
Rate of burning per day of 12 hours	18 tons
Percentage of residue or clinker ...	28·61 per cent.
Total weight of residue or clinker ...	5 tons 3 cwt.
Temperature in combustion chamber by copper test	2,000° Fahr.

CHESTER (40,000).—Destructors have not yet been adopted here. The refuse is tipped on low lying land.

COVENTRY (52,724).—Here a portion of the refuse is given to farmers; the remainder is tipped. The destructor question has been before the Council.

DEVONPORT (54,736).—A Willoughby Destructor was erected here by the Patentees on trial, but failed, and the Corporation declined to take it over from the Vendors.

DUDLEY (45,740).—Destructors have not yet been adopted here, but the question is under consideration in connection with the electric lighting scheme.

EXETER (37,580).—Destructors have not yet been adopted here, but the question is now under consideration.

GLOUCESTER (41,000).—Have recently contracted with Messrs. Heenan and Froude, Limited, for two of their twin cells.

GREAT GRIMSBY (56,000).—The Horsfall Company, Limited, have 12 cells in hand for this Corporation.

HANLEY (60,000).—The Horsfall Company, Limited, have eight cells in hand for this Corporation.

HASTINGS (72,668).—In 1889 a 4-cell Fryer Destructor was erected here, with a cremator, but this is not constantly used. Nine tons per cell per day are consumed.

IPSWICH (61,434).—The Council have had the question of erecting destructors before them for some three years past. A move is likely to be made shortly. Plans are at present before the Council. It is definitely decided to erect a destructor in connection with the Electric Light Station on the Portman Road site.

LINCOLN.—Here the refuse is tipped.

MIDDLESBOROUGH.—Here the refuse is tipped. In May, 1899, the Sanitary Committee decided to continue tipping for five years.

NEWPORT, MONMOUTHSHIRE.—Here the refuse is tipped.

NORTHAMPTON (65,500).—The Council are now considering the matter in connection with proposed electric traction scheme. Plans and tenders have been invited and sent in. The Borough Engineer has to report on same.

OXFORD (53,200).—The refuse is partly tipped, the remainder is sold for manure.

READING (69,477).—The refuse is tipped at the Sewage Farm, a portion being consumed on the grates of three Lancashire Boilers. The destructor question is being considered in connection with electric traction.

ROCHDALE (71,401).—Messrs. Meldrum Brothers erected two cells here some six years ago. Each cell burns about one ton per hour. In connection with the cells are two 30 ft. × 8 ft. Lancashire Boilers, which continuously give about 300 indicated horse power per hour from unscreened refuse alone.

The figures of two tests at Rochdale are here given. One test was made, it will be noticed, with the worst possible refuse obtainable, so that the difference in the efficiency of the destructor might be seen as compared with average conditions.

At Rochdale five Cornish Boilers are also fitted with Meldrum Patent Furnaces, and fired with refuse, the steam being used for desiccators dealing with excreta.

TESTS MADE ON THE MELDRUM PATENT DESTRUCTOR, AT THE CORPORATION SANITARY WORKS, ROCHDALE, UNDER THE SUPERVISION OF F. W. BROOKMAN, ESQ., RESIDENT ENGINEER.

At this station there are two 30 ft. × 8 ft. Lancashire Boilers attached to four Simplex grates, and the steam is used in connection with the manufacture of manure.

The refuse burnt was the ordinary refuse of the town, just as brought in by the carts. No screening of the material was attempted (except that a few bricks, tins, etc., were not fired by the attendants), and all the conditions were those of everyday practice.

Date of test	Mar. 1, 1895.	Nov. 14, 1895.	Nov. 15, 1895.
Duration of test	6 hours	6½ hours	6½ hours
Total refuse destroyed ...	11·4 tons	13·75 tons.	14·3 tons.
Refuse burnt per hour ...	4,356 lbs.	4,738 lbs.	4,945 lbs.
Refuse burnt per hour per square feet of grate ...	47·3 lbs.	52·6 lbs.	54·9 lbs.
Water evaporated per pound of refuse	1·64 lbs.	1·39 lbs.	1·47 lbs.
Equivalent evaporation from and at 212°	1·97 lbs.	1·68 lbs.	1·78 lbs.
Number of boilers used ...	two	one	one
Temperature of feed water	53° Fahr.	52° Fahr.	52° Fahr.
Total water evaporated ...	42,072 lbs.	42,900 lbs.	47,400 lbs.
Water evaporated per hour	7,012 lbs.	6,600 lbs.	7,290 lbs.
Equivalent evaporation from and at 212°	8,431 lbs.	7,080 lbs.	8,820 lbs.
Average steam pressure per square inch	113 lbs.	113 lbs.	114 lbs.
Percentage of CO_2 in products of combustion ...	15·9	-	---
Percentage of CO in products of combustion ...	nil		---
Percentage of free oxygen	2·2	—	---
Highest temperature in combustion chamber ...	1088 Fahr.		---
Lowest temperature in combustion chamber ...	1200° Fahr.		---

It was found that some heat passed the damper and evaporated 60 and 54 gallons of water per hour respectively, in the stand by boiler, these items were therefore included in the above figures.

The ordinary staff only were employed during these tests, which consists of three men who do the whole work; charging, clinkering, and wheeling clinker by turns. Cost of labour for burning the refuse, 7½d. per ton.

(*Signed*) F. W. BROOKMAN.

AN INSTANCE OF SPECIALLY BAD REFUSE SELECTED IN WINTER TO SHOW THE MINIMUM REACHED.

F. W. Brookman, Esq., Superintendent of Rochdale Sanitary Manure Works, writes as follows :—

> I purposely selected the loads of refuse as bad as I could get them, and the refuse consisted principally of very fine ashes ; when you consider that the moisture and the combustible does not come to half of the total weight of the refuse, you will be able to form some idea as to what really can be done in this class of work.
>
> This sample was much worse than we get in summer, and we find that while the *quality* does vary between winter and summer, yet it does so to a less extent than the *quantity*, and while there is less ashes and cinder there is more paper or light stuff accordingly, or in percentage.

TEST MADE AT ROCHDALE SANITARY WORKS, DECEMBER 18th, 1894.

Refuse burned	Unscreened
Duration of test	9 a.m. to 5.30 p.m., 8½ hours
Temperature of feed water ...	54° Fahr.
Area of grate	90 square feet
Number of boilers in use ...	2 Lancashire type each 30 ft. × 8 ft.
Total refuse burned	11 tons 6 cwts.
Refuse burned per hour ...	2,977 lbs. = 1 ton, 4 cwts. 3 qrs.
Percentage of clinker	50·11 per cent.
Total weight of clinker	5 tons 13 cwts. 1 qr.
Water evaporated	3,450 gallons
Water evaporated per hour ...	405·8 gallons
Water evaporated per lb. of refuse	1·36 lbs.
Temperature of combustion chamber	1660° to 2000° Fahr.
Average blast pressure in ashpits...	¾ in. of water
Average steam pressure ...	111 lbs per square inch

ST. HELENS (86,588).—Only a few weeks since the Beaman and Deas Patent Destructor was got to work here. The contract was in hand at the time Messrs. Beaman and Deas, Limited, went into liquidation, and Messrs. Meldrum Bros., Limited, who purchased their business recently, completed the contract.

Babcock and Wilcox boilers are used in connection with the cells, the steam being used for electrical traction. The figures of the official test are here given. It will be noticed that the refuse was actually burned at the rate of 103 lbs. per square foot of grate per hour.

OFFICIAL TEST OF BEAMAN AND DEAS' PATENT DESTRUCTOR.

ST. HELENS INSTALLATION.

Two cells in use only, and one Babcock and Wilcox Boiler, with 1,741 square feet of heating surface.

Date of test	April 10th, 1900
Duration of test (10.30 a.m. to 5.50 p.m.)	7 hrs. 20 mins.
State of weather	Fine, windy
Kind of fuel burned	Unscreened ashpit refuse
Total weight of fuel burned, 16 tons 18 cwt. 2 qrs. ...	=37,912 lbs.
Weight burned per hour ...	5,169 lbs.
Weight burned per square foot of grate area per hour (50 square feet)	103 lbs.
Total weight of clinker and ash, 5 tons 6 cwt. 1 qr.	11,900 lbs.
Percentage of clinker and ash ...	31·36 per cent.
Total water evaporated	48,216 lbs.
Water evaporated per hour ...	6,575 lbs.
Water evaporated per lb. of refuse actual	1·27 lbs.
Water evaporated per lb. of refuse from and at 212° Fahr., including economiser	1·54 lbs.
Temperature of water in tanks ...	46° Fahr.
Temperature of feed water from economiser	190° Fahr.
Average steam pressure... ...	132 lbs.
Average air pressure under grates	3·1 in.

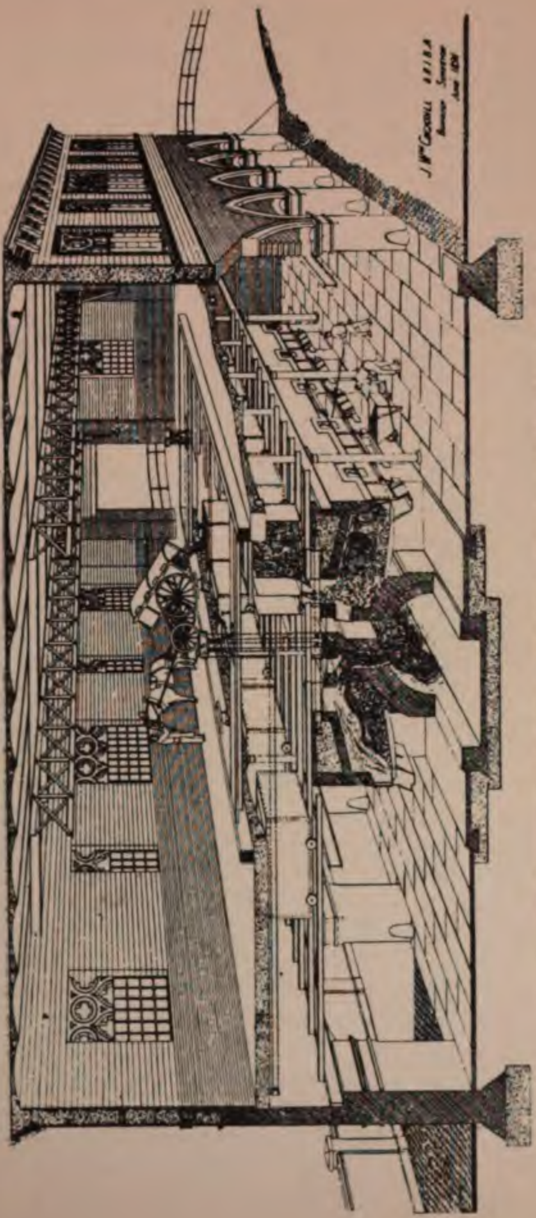


FIG. 20.—GREAT YARMOUTH DESTRUCTOR, ERECTED BY MESSRS. MANLOVE, ALLIOTT & CO., LTD.
PLAN SHOWING METHOD OF WORKING.

Temperature in combustion chamber, by copper test ...	2000° Fahr.
Temperature in main flue, before economiser	537° Fahr.
Temperature in main flue, after economiser	358° Fahr.
Percentage of CO_2, average for 21 readings	10·4 per cent.
Percentage of O, average for 20 readings	9·16 per cent.

SOUTHAMPTON (100,000).—In 1897 a 6-cell Fryer Destructor was erected, and extended in 1898; in 1895 Messrs. Goddard, Massey and Warner erected four cells. The cost per ton destroyed is 6d. for labour only; the power derived is used for sewage pumping, etc.

SOUTH SHIELDS (98,900).—A quantity of the refuse is barged out to sea, the remainder is sold to farmers for manure.

STOCKPORT (80,000).—The refuse is tipped at present, but the erection of destructors is being considered by the Council. Tipping is said to cost £5,700 per annum.

WALSALL (79,000).—In 1898 the Sub-Committee of Inspection recommended that in view of the great cost of a destructor, one be not provided if suitable tips could be found.

WEST BROMWICH (50,489).—Nothing has yet been done in the way of sanitary refuse disposal; it is tipped.

WORCESTER (45,000).—Here the refuse is collected weekly, and tipped on low lying land.

GREAT YARMOUTH (51,000.)—Messrs. Manlove, Alliott and Company, Limited, erected a destructor here in 1898. (See Fig. 20.)

YORK (72,744).—A 6-cell destructor was erected here in 1895 by Messrs. Goddard, Massey and Warner.

CHAPTER XIII.

PROGRESS IN REFUSE DESTRUCTION IN INCORPORATED TOWNS.

Aberystwyth	8,725
Abingdon	6,557
Accrington	38,063
Messrs. Horsfall have a 6-cell destructor in hand to work in connection with electric lighting; this is now nearing completion.	
Aldeburgh	2,159
Andover	6,800
Appleby	1,776
Under consideration only last year.	
Arundel	2,645
Ashton-under-Lyne	40,463
Have a 6-cell Horsfall Destructor. The figures of a recent test are here shown.	

TEST OF HORSFALL REFUSE DESTRUCTOR AT ASHTON-UNDER-LYNE.

An official test of the destructor and multitubular boilers took place on Wednesday, June 13th. The test commenced at 3.30 on Wednesday afternoon, and terminated at 3.30 on Thursday afternoon, making the duration of the test a full working day of 24 hours. Previous to the test, the destructor furnaces had been in operation for eight hours, and the flues leading to the boilers were, at the time of starting, at a good red heat. The quality of the refuse used during the test was of good average quality. Throughout the trial the pressure of air maintained in the ashpits averaged 1¼ inches, the time allowed for a complete charge in each fire being 1½ hours. With six furnaces this meant that every quarter of an hour one fire was being clinkered and charged throughout the test. The various readings were carefully taken throughout, and are summarised as follows :—

Total refuse destroyed, 134,050 lbs....	59·84 tons
Total water evaporated, 97,851 lbs. ...	43·68 tons
Total refuse per cell per 24 hours, 22,341 lbs	9·97 tons
Total water evaporated per hour, 4,077·16 lbs.	1·82 tons
Water evaporated per lb. of refuse, actual conditions	·729 lbs.
Water evaporated per lb. of refuse from and at 212°	·783 lbs.
Mean pressure of steam	122·6 lbs.
Mean temperature of feed... ...	179·840 Fahr.
Total amount of clinker formed 35,084 lbs.	15 tons 13 cwt. 1 qr.
Percentage of clinker to refuse ...	16·17 per cent.
Mean temperature of gases before entering boiler...	1241·42° Fahr.
Highest reading temperature of gases before entering boiler	1365° Fahr.
Mean temperature of gases at chimney	337·1° Fahr.
Ash-pit draught throughout ...	1·25
Steam taken for blast per hour ...	1,741·375 lbs.
Percentage to total steam raised per hour	42·6 per cent.
Total useful steam available ...	2,335·785 lbs.
Total horse power, assuming 20 lbs. be used per indicated horse power	203·858
Total horse power after deducting steam for blast...	116·789

Bacup 24,500

Here the refuse is tipped at present.

Batley 32,000

Have a 6-cell destructor, erected by Messrs. Manlove, Alliott and Company, Limited ; 3·5 tons are consumed per day, the cost of destruction being 7½d. per ton. A fume cremator is used, with coke as fuel ; the cost of cremating the fumes from each ton of refuse is 7d.

Banbury	12,678
Bangor	10,600

The Corporation have recently contracted with Messrs. Meldrum Brothers, Limited, to erect a Beaman and Deas Patent Destructor in connection with the new Electric Lighting Station.

Basingstoke	7,960

Here for many years past the refuse has been burned in Cornish Boilers fitted with Meldrum Patent Furnaces, the power resulting therefrom being used for pumping the sewage.

Barnsley	34,537
Barnstaple	13,058
Blackpool	45,414

Messrs. Manlove, Alliott and Company erected an 8-cell destructor in 1890, and with this a fume cremator is regularly used, with coke as fuel. Four Horsfall Cells were erected in 1895; 8½ tons per cell is consumed at a cost of 1s. 6½d. per ton, exclusive of delivery, interest, and sinking fund. The most recent installation is a Mason's Gasifier, which was erected last year.

Beaumaris	2,202
Beccles	6,609
Bedford	34,500
Berwick-on-Tweed	13,378
Beverley	13,300

Messrs. Goddard, Massey and Warner have just received the contract for a small destructor.

Bewdley	2,876
Bideford	7,031
Blandford	3,974
Bodmin	5,151
Boston	14,593
Brackley	2,591
Brecknock	5,794
Bridgnorth	5,723
Bridgwater	15,000
Bridport	6,611

Brighouse 24,000
Considering.

Buckingham 3,364
Bury St. Edmunds 16,330
Bournemouth 58,000

Here the first cells were erected in 1887, by Messrs. Manlove, Alliott and Company, and extended in 1892; some Warner Cells were also built in 1891 and 1895. Each cell deals with four to five tons per day, at a cost of 8d. per ton for labour and repairs only.

Burslem 34,480

Four Fryer Cells were erected in 1889. Each cell consumes six tons per day, at a cost of 1s. 5d. for labour and materials only. A fume cremator is used regularly, being fired with screened ashes.

Burton-on-Trent 51,150

An 8-cell Fryer Destructor was erected in 1890, and also a fume cremator; this is fired with coke breeze, and coke; 8½ tons of refuse are consumed per cell per day, costing 1s. 7¼d. per ton for labour and materials only. Messrs. Meldrum Brothers, Limited, recently erected two small cells, which consume between them 26 tons per 24 hours.

Cambridge 37,000

Here Messrs. Manlove, Alliott and Company erected six cells of the Fryer type, with Boulnois and Brodie's patent charging gear. Three Babcock and Wilcox Boilers are provided to utilise the waste heat. Four cells only and two boilers are used at a time, and each cell consumes 5½ tons per day. The boilers are 80 horse power each, and are so arranged that two cells work with one boiler. It is claimed that four cells and two boilers have developed 140 indicated horse power. The cost of labour in burning the refuse is 1s. 3d. per ton.

Cardigan... 3,432
Carlisle 42,000
Carmarthen 10,338

The erection of a destructor is now being considered by the Corporation, tips not bein [illegible] btainable.

Carnarvon 10,000

Under consideration in connection with electric lighting.

Chard 4,315

Refuse is partly tipped, the remainder sold for manure.

Chatham 31,957

Chelmsford 11,840

Refuse is tipped at present, but the adoption of a destructor is under consideration now.

Cheltenham 48,944

Messrs. Manlove, Alliott and Company erected eight Fryer Cells in 1896. From four to five tons per cell per day are consumed at a cost for labour of 7·6d. per ton.

Chipping Wycombe 1,435

Chesterfield 24,000

The Horsfall Company, Limited, have two cells in hand to be erected at the Sewage Works.

Chichester 10,808

The Corporation are now considering the question.

Chippenham 4,618

Chipping Norton 4,222

Chorley 25,200

Messrs. Goddard, Massey, and Warner now have a 4-cell destructor in hand.

Clitheroe 11,000

Colchester 31,459

The question of erecting a destructor is now before the Council. The refuse has recently been tipped on allotments and burned there.

Colne 25,000

Have a 2-cell Beaman and Deas patent destructor giving very satisfactory results ; it is proposed to use the power for electric lighting.

The authorities here intend ultimately to utilise the power from the destructor for electric lighting, and with that object in view Mr. A. C. Cooper, the Borough Electrical Engineer, recently made a test, obtaining the following results :—

Water evaporated per lb. of refuse burned (actual), 1 lb.

Temperature of feed water, 100° Fahr.

Water evaporated per lb. of refuse burned (from) and at 212° Fahr., 1·15 lbs.

Steam pressure, 90 lbs.

Horse power developed, allowing 20 lbs. water per horse power hour, 203 indicated horse power.

Duration of test, 9½ hours.

Cost of burning (for labour only), 10½d. per ton.

Carting, office expenses. etc., 2s. 1d. per ton.

Interest and sinking fund, 1s. 1d. per ton.

Dr. Lovett, the Medical Officer of Health, reports that during the first nine months 3,132 tons of refuse was dealt with, the average cost per ton for labour, in burning only, being 10½d. This figure, he says, corresponds with the 2s. 2d. per ton at Poplar, etc.

Dartmouth 8,025

The destructor question is now before the Council. The quantity of refuse produced is only between 8 and 10 tons per day, including a small proportion of light trade refuse.

Darwen 34,192

In September last Messrs. Meldrum Bros., Ltd., erected two 4-cell units of their patent Simplex Destructor and two 30 ft. by 8 ft. Lancashire boilers. One unit only is used at a time and one boiler. 40 tons per 24 hours is the usual rate of combustion, but as much as 52 tons have been consumed, this being at the rate of 55 lbs. per square foot of grate per hour. The whole of the public and private electric lighting power is obtained from refuse alone, this being at present 250 indicated horse-power.

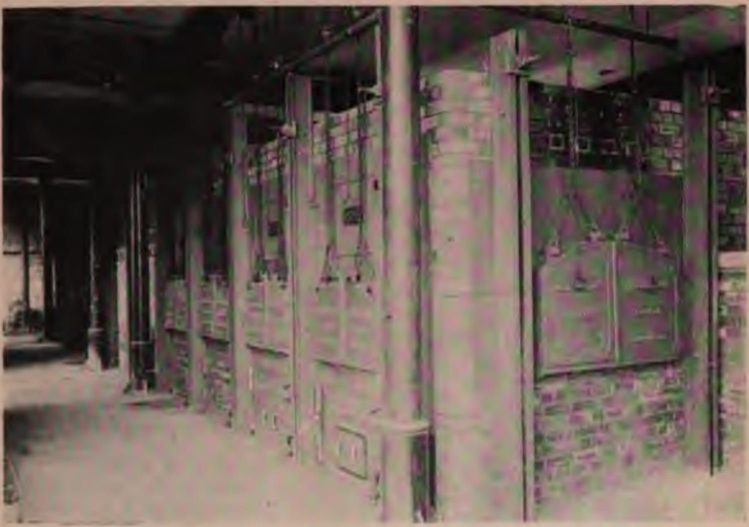


FIG. 21.—MELDRUM'S PATENT "SIMPLEX" DESTRUCTOR AT DARWEN.

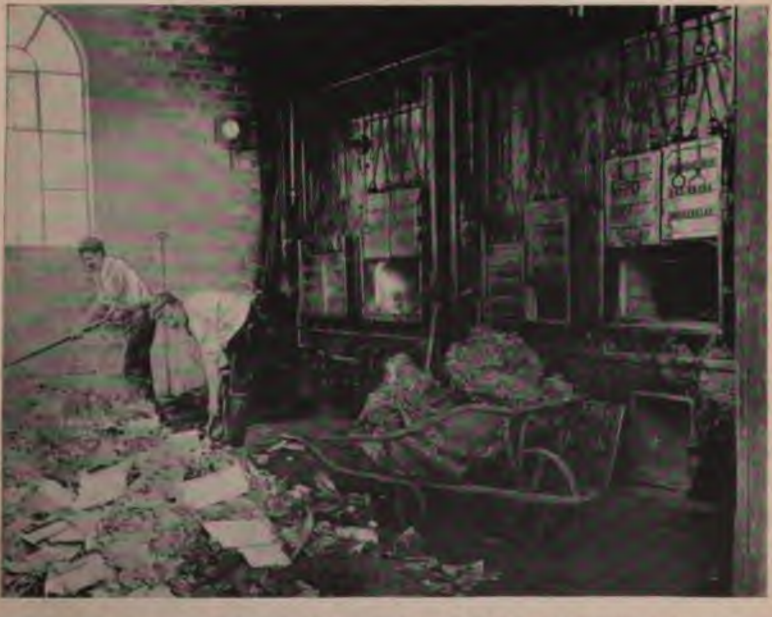


FIG. 22.—MELDRUM'S "SIMPLEX" DESTRUCTOR AT HEREFORD, SHOWING SECTION OF GRATE BEING FIRED.

(To face page 126.)

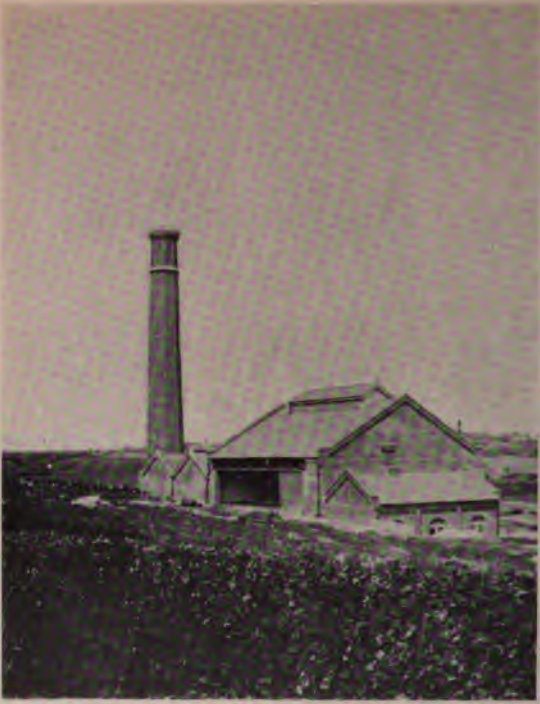


FIG. 23.—HORSFALL'S DESTRUCTOR AT RAMSGATE. GENERAL VIEW, SHOWING BACK OF BUILDING.

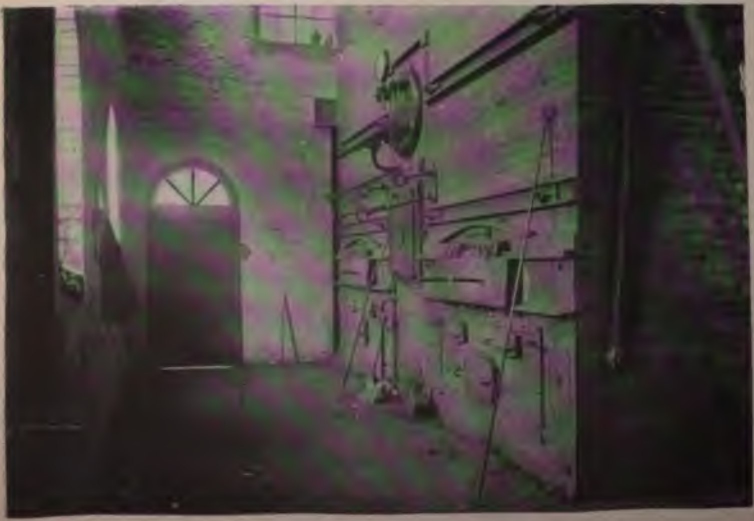


FIG. 24.—WARNER'S "PERFECTUS" DESTRUCTOR AT TORQUAY.

Figures of a test are here given :—

OFFICIAL TEST OF MELDRUM'S PATENT SIMPLEX DESTRUCTOR ERECTED IN CONNECTION WITH THE PUBLIC ELECTRIC LIGHTING STATION.

One unit, consisting of a continuous grate 19 ft. long by 5 ft. 6 in. from back to front, with one Lancashire Boiler 30 ft. long by 8 ft. in diameter, was in use.

Date of test—September 21st, 22nd and 23rd, 1899.

Duration of test—48 hours continuous.

State of weather—Very heavy showers ; rainfall, ·92 first day ; and ·16 on second day.

Total quantity of refuse destroyed—63·88 tons.

Description of refuse—Unscreened ashpit refuse, 61·88 tons ; slaughter-house and fish market offal, 2 tons.

Average percentage of moisture throughout—35 per cent.

Total weight of clinker remaining—19½ tons=30·6 per cent.

Temperature of feed-water average—185° Fahr.

Water evaporated per lb. of refuse, actual—1·48 lbs.

Water evaporated per lb. of refuse from and at 212° Fahr.—1·55 lbs.

Average steam pressure per square inch—183 lbs.

Average temperature of combustion chamber—1633° Fahr.

Highest temperature of combustion chamber—Over 2000° Fahr. ; copper melted, 5 times.

Lowest temperature of combustion chamber—1250° Fahr.

Average temperature of flue after leaving boiler—703° Fahr.

Average temperature of flue after leaving regenerator—585° Fahr.

Average temperature of feed air from regenerator—328° Fahr.

Daventry 3,989

The refuse is tipped.

Deal 9,000

The refuse is partly tipped, the remainder being sold to farmers.

Denbigh 6,

Devizes ... ...

Dewsbury	29,847
Have a 2-cell Beaman and Deas Patent Destructor. Each cell consumes 15 tons per day at a cost of 13·83d. per ton for wages only.	
Doncaster	29,534
Dorchester	7,246
Douglas, Isle of Man	22,500
Dover	33,550
Partly tipped ; remainder towed out to sea.	
Droitwich	4,021
Dunstable	5,085
Durham	14,858
Considered in 1898, but abandoned on account of great cost.	
Eastbourne	44,000
Messrs. Manlove, Alliott and Co. erected 6 cells in 1890. Five tons per cell per day are consumed ; cost of burning, 1s. 4d. per ton. Two multitubular boilers are used to take up the waste heat, the steam being used for air compressors in connection with Shone's ejectors. Plans and tenders are now under consideration for pulling down the existing destructor and erecting in place of same a modern high temperature plant to work in connection with the Central Electricity Supply Works.	
East Retford	10,603
Eccles, Lancs.	35,000
Partly tipped and partly sold.	
Evesham	6,000
Eye	2,064
Falmouth	12,215
Considering.	
Faversham	10,478
Tipped and sold.	
Flint	5,247
Folkestone	27,000
Sold to contractors for £50 per year ; the erection of a destructor was under consideration some three years ago, and the question has recently been revived owing to complaints.	

Glastonbury	... 4,119
Tipped.	
Glossop	... 22,416
Tipped.	
Godalming	... 8,202
Godmanchester	... 2,095
Grantham	... 16,746
Gravesend	... 24,087
Now under consideration ; it is proposed to erect the destructor in connection with electric lighting station.	
Guildford	... 14,310
Tipped at Hog's Back. The question of providing a refuse destructor is now before the Council, and a deputation will be visiting a number of destructors at work very shortly, with a view to recommending the most suitable type to the Council for adoption.	
Harrogate	... 20,000
Under consideration in connection with electric lighting.	
Hartlepool	... 26,000
Harwich...	... 10,000
Tipped partly ; remainder sold for manure. The question of providing a destructor is at present before the Council, and at an early date a deputation is likely to inspect some destructors at work.	
Haslingden	... 18,225
Under consideration. An early decision in favour of a destructor is anticipated.	
Haverfordwest	... 6,079
Helston	... 3,198
Hemel Hempstead	... 10,500
Now considering.	
Henley-on-Thames	... 5,433

Hereford City 22,000

Messrs. Meldrum erected 2 cells in 1897 at the sewage works, using two existing Galloway Boilers, each 6 ft. 6 in. in diameter, to take up the heat. One and a quarter million gallons of sewage is pumped daily with 10 tons of refuse as the only fuel, the lift being 36 ft.

One and a half pounds of water are evaporated per lb. of refuse burned, and up to the present the repairs have been "nil." Figures of a test are here given.

Hertford... 9,023

Heywood 26,000

The Corporation have recently contracted with Messrs. Meldrum Bros., Limited, to erect an 8-cell Simplex Destructor.

Honiton 3,216

Hove 34,331

Huntingdon 4,346

Hyde 32,000

Here Messrs. Goddard, Massey and Warner erected a 4-cell destructor. One of the cells erected by Messrs. Goddard, Massey and Warner was altered by Messrs. Meldrum Bros., Limited, with a view to doubling the destroying capacity, and for the raising of steam. The Corporation have now accepted plans for the reconstruction of the remaining cells on Meldrum's principle.

Ilkeston 25,000

Now considering. It is likely that a destructor will be adopted in connection with the electric lighting.

Jarrow 33,682

Keighley 38,000

Tipped, but the question is under consideration.

Kendal 14,400

Tipped.

Kidderminster ... ...

Kidwelly... ... ...

Kings Lynn ... ...

STS MADE ON THE MELDRUM PATENT DESTRUCTOR, AT THE CITY OF HEREFORD SEWAGE OUTFALLS WORKS, UNDER THE SUPERVISION OF JOHN PARKER, ESQ., CITY SURVEYOR.

st ...	May 4, 1898.	May 5, 1898.	May 6, 1898.
of test	10 hours (7 a.m. to 5 p.m.)	10¼ hours (7.15 a.m. to 5.30 p.m.)	10 hours (7 a.m. to 5 p.m.)
Weather	Steady rain till 8.30, when it cleared	Fine at start; commenced to rain at 1 o'clock and continued to end	Fine all day.
Kind of fuel burned	Unscreened ashpit refuse	Unscreened ashpit refuse	Unscreened ashpit refuse
Total weight of fuel burned	19,768 lbs.	19,012 lbs.	19,712 lbs.
Weight burned per hour	1,976 lbs.	1,855 lbs.	1,971 lbs.
Weight burned per sq. ft. of grate area per hour	54·88 lbs.	51·52 lbs.	54·75 lbs.
Total weight of clinker and ash	6,699 lbs.	6,804 lbs.	5,040 lbs.
Percentage of clinker and ash	33·88 per cent	35·7 per cent	25·56 per cent
Percentage of moisture	24·5 per cent	27·0 per cent	25·0 per cent
Total water evaporated	26,254 lbs.	25,570 lbs.	29,800 lbs.
Water evaporated per hour	2,625 lbs.	2,494 lbs.	2,980 lbs.
Water evaporated per pound of refuse (actual)	1·32 lbs.	1·34 lbs.	1·51 lbs.
Water evaporated per pound of refuse from and at 212° F.	1·58 lbs.	1·60 lbs.	1·82 lbs.
Temperature of feed water	48°	48°	48°
Average steam pressure	70 lbs.	70·2 lbs.	70·92 lbs.
Average steam pressure at blowers	64·37 lbs.	64·55 lbs.	65·21 lbs.
Average air pressure under grates by water gauge	1·45 in.	1·37 in.	1·82 in.
Chimney pull, by water gauge	⅜ in.	⅜ in.	⅜ in.
Temperature in combustion chamber, by Copper test	Over 2000° Fahr.	Over 2000° Fahr.	Over 2000° Fahr.
Temperature of waste gases, leaving damper	25 readings 611·5° Fahr.	36 readings 638·8° Fahr.	41 readings 715·12° Fahr.
Percentage of Carbonic Acid (CO_2) by econometer	25 " 15·56 per cent	39 " 16·84 per cent	41 " 16·27 per cent
Percentage of Carbonic Acid, Orsat app.	20 " 14·92 per cent	16 " 16·83 per cent	14 " 16.38 per cent
Percentage of free Oxygen (O), Orsat app.	20 " 5·40 per cent	16 " 3·54 per cent	14 " 3·74 per cent
Percentage of Carbonic Oxide (CO), Orsat app.	20 " nil.	16 " nil.	14 " nil.
Size of boiler, 22 ft. × 6 ft. 6 in., with two flues, each 2 ft. 9 in.	During the above test the sludge presses and liming plant worked the whole time. Both sewage pumps worked from 7 o'clock to 10.50; after that one pump only. Steam in excess was blown off.	The sludge presses and liming plant were running the whole time. Both pumps from start to 11.30; then one pump till 3.45; then both again to the finish. Steam in excess was allowed to blow off.	The sludge presses and liming plant worked the whole time of test. Two pumps worked from 7 o'clock to 11.20, then one pump for the remainder of time. Steam in excess was allowed to blow off.

One-and-a-quarter million gallons of sewage pumped per day of ten hours, on an average, to a height of thirty-six feet.

(*Signed*) JOHN PARKER.

Kingston-on-Thames 34,000

Now considering. Specifications, tenders and plans were invited some two months since for a destructor. Mr. Stephen H. Terry is to report to the Council on the various offers. Whoever may secure the contract, this will be a unique installation, as the power will not be utilised.

Lancaster 39,727

The Corporation lately contracted with Messrs. Meldrum Bros., Limited, to erect an 8-cell Simplex Destructor and two 30 ft. × 8 ft. Lancashire Boilers, for a working pressure of 200 lbs. to the square inch. This installation will now very shortly be started.

Launceston 4,315

Leamington 27,000

Now under consideration. Tenders and plans are now before the Council.

Leominster 5,675

Lewes 10,997

Lichfield... 7,864

Tipped.

Liskeard... 3,984

Llanidloes 2,574

Longton 39,104

Four Fryer Cells were erected in 1887, and Messrs. Goddard, Massey and Warner put up two of their Warner Perfectus Cells in 1895. The Fryer Cells each deal with about 6½ tons per cell per day. The Warner Cells are fitted with forced draught, and burn rather more. The cost per ton destroyed is 11d., including labour and materials; a fume cremator is used.

Loughborough 22,000

Here the refuse is dealt with in a destructor designed by Messrs. H. Coltman and Sons, the only one of the type working in the country. Only one cell has been erected; it is said that this can deal with from 12 to 20 tons per day; the cost of burning is 1s. 2d. per ton.

Louth 10,040

Tipped at present, but a refuse destructor is under consideration.

Lowestoft 27,000

The Horsfall Destructor Company, Limited, have erected four cells recently here.

Ludlow (under consideration) 4,460

Luton 37,000

During this summer bitter complaints have been made by residents near the refuse tips, and it is exceedingly likely that the Council will arrive at an early decision to adopt a destructor.

Lydd 2,051

Lyme Regis 2,364

Lymington 4,451

The refuse is sold by tender.

Macclesfield 36,069

Part is sold to farmers, the remainder is tipped.

Maidenhead 34,000

Although a combined scheme of electric lighting and refuse destruction had been practically decided upon here, at the last moment the Council determined to proceed with the electric lighting only, and to continue to tip the refuse.

Maldon 5,836

Under consideration.

Malmesbury 2,964

Mansfield 15,925

Margate 18,662

The question of providing a destructor has just now come before the Council, owing to complaints *re* tipping.

Marlborough 3,012

Tipped.

Middleton 2,500

Tipped partly, remainder sold for manure at present, but the erection of a destructor is under consideration.

Monmouth 5,470

Morley 21,068

Morpeth	5,219
Mossley	15,000
Neath	13,000
Nelson	33,000

Messrs. Meldrum Bros., Limited, have a 4-cell Simplex Destructor in hand at the present time for this Corporation, in connection with electric lighting.

From report by Borough Engineer and Health Superintendent, dated March, 1899 :—

VALUE OF NELSON REFUSE.

Calculating from the refuse removed in Nelson during 1898, we find that 8,283 loads of ashes were carted to tips and to the destructor for the 12 months, ending 31st December last. Of this quantity we may safely assume that 10 per cent. would not find its way to the new destructor, but would be used for road making, or filling up hollows at sundry places when affording an accessible and convenient tip.

This leaves 7,455 loads of refuse, of which 20 per cent. consists of light refuse and paper. The total weight of refuse to be dealt with at the new destructor in 12 months, therefore, we estimate as follows :—

5,964 loads of ashes, average weight 1 ton ...	5,964	tons
1,491 loads of light refuse, average weight 10 cwt.	745	,,
1,025 tubs of offal, average weight 2 cwt. ...	102	,,
3,600 tubs of garbage, average weight 1 cwt....	180	,,
Total	6,991	,,

The total number of working days per annum is 278, and 6,991 divided by 278 is practically 25 tons per day of 24 hours. From these figures we may now arrive at the available horse power on the basis previously laid down, viz.: 1 lb. of water evaporated per 1 lb. of refuse burned. Twenty-five tons multiplied by 2,240 lbs. per ton gives 56,000 lbs. of refuse, equal to 56,000 lbs. of water evaporated in 24 hours, or 2,333 lbs. of water per hour continuously. Allowing the consumption of 20 lbs. of water for every horse power available, we find 2,333 divided by 20 is equal to 116 horse power. From this, however, we must deduct the steam used in producing the forced blast, and which, under satisfactory conditions, is found to be equal to one-seventh of the power produced, or 16 indicated horse power in this case. Beyond this again there is the power utilised in clinker crushing and mortar making, which would amount to some 10 indicated horse power. After allowing for these, therefore, we have about 90 indicated horse power available for use in connection either with an electric lighting installation or for other purposes.

Newark	... 14,457
Newcastle-under-Lyme	... 18,452
Tipped.	
Newbury	... 11,002
Now considering.	
Newport, Isle of Wight	... 10,216
Okehampton	... 1,879
Ossett	... 12,000
Considering.	
Oswestry	... 10,000
Penryn	... 3,240
Partly tipped, remainder sold.	
Penzance	... 12,432
Partly tipped, remainder sold. Now under consideration in connection with electric light.	
Peterborough	... 29,000
Partly tipped, remainder sold.	
Pontefract	... 7,702
Poole	... 18,700
Pwllheli	... 3,232
Ramsgate	... 24,753
The Corporation have recently placed a contract with the Horsfall Destructor Company, Limited, for a 4-cell destructor. This installation has just been completed (Fig. 23).	
Rawtenstall	... 30,000
Contract recently placed with Messrs. Heenan & Froude, Limited.	
Reigate	... 25,000

Richmond	31,000
Now considering.	
Richmond, Yorkshire	4,216
Ripon	7,512
Rochester	31,500
Tipped on marsh land.	
Romsey	4,276
Rotherham	52,000
Messrs. Manlove, Alliott and Company erected a 6-cell Fryer Destructor in 1892 ; forced draught has since been added with improved results. The plant was extended in 1898. The cost per ton burned varies from 1s. 1d. to 1s. 4d. per ton, labour and materials only included.	
Ruthin	2,810
Ryde, Isle of Wight	10,952
Rye	3,871
Tipped.	
Saffron Walden	6,104
St. Albans	15,000
St. Ives, Cornwall	6,094
St. Ives, Hunts	3,037
Salisbury	15,533
Tipped at present, but the question is now under consideration. It is probable that a destructor will be combined with the sewage pumping scheme.	
Saltash	2,745
St. Heliers, Jersey	
Have a 2-cell Horsfall Patent Destructor.	
Sandwich	3,000
Scarborough	35,000
Shaftesbury	2,122
Shrewsbury	26,967
Under consideration.	
Southend	23,000
Now considering.	
South Molton	3,126
Southport	49,678
Have recently ordered a 6-cell Horsfall Patent Destructor.	

Southwold 2,311

Have a very small destructor designed by Borough Surveyor.

Stafford 20,270

Have a Fryer 4-cell Destructor, erected by Messrs. Manlove, Alliott and Company, Limited. Two water-tube boilers take up the waste heat. Eight tons of refuse are destroyed per cell per day at a cost of 9d. per ton for labour.

Stalybridge 30,000

Under consideration.

Stamford 8,358

Stockton-on-Tees 54,000

Have lately ordered a 2-cell Horsfall Patent Destructor.

Stoke-on-Trent 24,027

Stratford-on-Avon... 8,318

Under consideration.

Sudbury 7,059

Now considering the question. It is practically decided to combine a destructor with the proposed electric light station.

EXTRACT FROM REPORT BY W. C. HAWTAYNE, ESQ., M.I.E.E., AND T. W. A. HAYWARD, ESQ., SUDBURY, BOROUGH ENGINEER, AND THE ELECTRIC LIGHT COMMITTEE.

I understand that the Corporation has under consideration the question of Refuse Destruction, and I think it well to point out that many Municipalities are now burning town refuse to raise steam for useful work. I certainly consider that this method of disposing of town refuse is far and away preferable to any other, and its advantages should not be overlooked. In my opinion, the tipping of refuse into pits a short distance from a town is a most unsanitary method of disposal, besides being a costly one, and it should be borne in mind that even if the bad effects of such an arrangement are not in evidence at present, later on, when building takes place in the neighbourhood of the tips, and perhaps on the very tips themselves, the folly of this method of disposal of refuse may very likely be brought home to the Authorities. The waste heat produced by a Destructor can be very well used for generating steam for Electricity supply, and is so used at many places, and I see no reason why a combined Electricity and Destructor Works should not be put down in Sudbury.

By combining the Destructor with the Electricity works, there would be a saving in buildings, owing to only one chimney shaft being required, a saving in labour and supervision, owing to both undertakings being together, a saving in cost of generating Electricity, owing to the assistance the Destructor could give to the Electricity works, besides the saving in the sewerage pumping arrangements.

The principal makers of Destructors are now prepared to guarantee 1 lb. of steam generated for every 1 lb. of refuse destroyed in the average town, and if a similar result can be obtained at Sudbury—and I see nothing to prevent such a result—it would be a distinct advantage to the Corporation if this Destructor is erected in combination with the Electricity works.

The extra cost would be roughly £2,000, and this I suppose would be charged to the Sanitary Department, who would sell to the Electricity Department all steam generated at a fair price.

I have not been furnished with accurate information as to the amount of town refuse collected each year, but I find that the cost of collection is £140 per annum, which, at an average of 2s. per load, would make it appear that about 1,400 tons of refuse are collected annually. I cannot help thinking that this figure is rather low, and I have therefore reckoned on 2,000 tons being collected. At Epsom—a similar town to Sudbury, without nearly as many shops—the amount of refuse per annum is over 3,000 tons.

If you are able to obtain 1 lb. of steam per 1 lb. of refuse destroyed, you should obtain not less than 4,480,000 lbs. of steam per annum, which represents practically the total amount of steam required by the Electricity supply works. Owing to the fluctuating nature of an Electric Light load, it will not be possible to obtain the full benefit of this amount, and I have therefore assumed for the purposes of this estimate that about half the amount of steam generated will be turned to useful work, and this will effect a saving in the annual coal bill of the Electric Lighting undertaking of approximately £200 per annum—sufficient to cover interest and sinking fund charges on the extra cost of the Destructor, and leave a reasonable profit.

Your Committee approve of the foregoing report, and would add that from information we have obtained from other towns that have adopted this form of light, we are led to believe that Mr. Hawtayne's figures as to the cost of the works will certainly not be exceeded, and that his estimate of the net profit to be derived may probably be more than realised.

From the report of our Borough Engineer, who has visited several towns where modern Refuse Destructors are at work, we are led to believe that the estimate Mr. Hawtayne places upon the steam raising power to be derived from refuse is much under what we may reasonably expect. Some first-class firms are prepared to guarantee 1½ lbs. of steam per 1 lb. of refuse consumed, having achieved better results even than this in some instances. Roughly speaking, the value of refuse as a steam generator may be said to be equal to one-sixth, and in some cases one-fifth that of steam coal. As to the quantity of refuse available, it must be borne in mind that hitherto no systematic mode of collection has been in vogue in Sudbury, and therefore, the 2,000 tons mentioned is only an approximate estimate.

Sutton Coldfield 8,685

Now considering.

Tamworth	... 7,000
Taunton	... 20,000

Now considering, tenders and plans are before the Council.

Tenby	... 4,542
Tenterden	... 3,429
Tewkesbury	... 5,269
Thetford...	... 4,244
Thornaby-on-Tees	... 17,000
Tiverton	... 10,892

Tipped at present, but a destructor is under consideration.

Todmorden	... 24,750
Torquay	... 26,000

Messrs. Goddard, Massey and Warner erected four cells of their Warner Perfectus type two years since, and two Multitubular Boilers were included. Each cell deals with about eight tons of refuse per day. Here will be seen figures of official tests; this installation is also illustrated. A number of complaints have been made during the summer *re* smoke. It should be stated that the destructor is erected in a valley.

TESTS AT TORQUAY WITH WARNER'S "PERFECTUS" DESTRUCTOR,

ERECTED BY MESSRS. GODDARD, MASSEY AND WARNER, LTD.

Four Warner's "Perfectus" Cells, two Multitubular Boilers, and oil jet cremator.

Before the tests were made the component parts of the refuse of the Borough were carefully ascertained. For the December and January tests, from a total weight of 37 tons 7 cwt. 1 qr. 21lbs., the refuse was found to be composed of the following :—

	Tns.	cwts.	qrs.	lbs.	
(1) Paper, card board boxes, straw packing material and similar matter ...	4	12	0	0	=12·29 per cent.

	Tns.	cwts.	qrs.	lbs.	
(2) Vegetable and garden refuse, impregnated with fine ash	19	10	0	0	=52·072 per cent.
(3) Screenings, cinders, clinkers, pieces of small coal, and similar matter	2	8	3	0	=6·51 per cent.
(4) Fine ashes and dust ...	9	10	1	7	=25·423 per cent.
(5) Pots, pans, crockery, bottles, and the like ...	1	3	3	0	=3·172 per cent.
(6) Rags, bones, &c. ...	0	3	2	14	=0·3506 per cent.

The component parts of the refuse for the June test, from sample of about 16 cubic yards, weighing eight tons, being of such an extraordinary nature, were more carefully sorted, and the result was as follows :—

	Cwts.	qrs.	lbs.
Fish offal	3	2	21
Meat and poultry offal		3	17
Waste bread, bits of cake		1	15
Brickbats, stones		2	3
Bits of wood, old boxes			23
Old tins, pans, pails	3	2	9
Bits of old iron	1	1	0
Vegetable refuse	11	3	9
Garden prunings	4	1	0
Bones		1	5
Pots	1	2	4
Bottles and glasses	1	3	18
Straw	1	1	8
Waste paper	3	2	17
Rags			17
Bits of canvas	1	1	7
Old boots and shoes			11
Fine dust...	77	0	0
Screenings	45	2	0
Bits of coal		2	17
Bits of coke			21

Test No. 1.—December 21st, 1898.

Number and type of furnaces ... Four Warner "Perfectus"

Number and position of boilers	Two between furnaces.
Nature of refuse burned	Unscreened ashpit refuse, very dry, and containing a large quantity of waste paper, straw, and packing paper. The first four loads delivered, being very light, were absolutely destroyed in the first 1¼ hours.
State of weather	Very fine and dry.
Duration of test	12 hours, 8.30 a.m. to 8.30 p.m.
Number of men engaged	Three, in addition to contractors representative superintending running of machinery
Wages of men	12s. 8d., including above.
Total weight of refuse delivered to destructor during the day	19 tons 7 cwts.
Total weight of refuse burned during 12 hours	16 tons 7 cwts.=36,624 lbs.
Cost of burning per ton	9·29d.
Colour of smoke from chimney	First observations 9.30 a.m. light brown; 2.30 p.m. almost colourless 4.0 p.m. light brown.
Total quantity of water evaporated, starting at 8 a.m., from a cold water feed, steam gauge standing at 0·0	1,224 gallons=12,240 lbs.
Refuse burned per lb. of water evaporated	2·99 lbs.
Water evaporated per lb. of refuse burned	·334 lbs.
Average steam pressure maintained during 12 hours in each boiler (31 readings)	57 lbs.
Highest reading at 11.30 a.m.	105 lbs.
Lowest reading at 8.0 p.m.	38 lbs.

Total indicated horse power per hour, allowing 20 lbs. water evaporated per indicated horse power ... ... 51 indicated horse power

		Tons	cwts.	qrs.
Residuals from total quantity of refuse delivered and burned, including that left on completion of test	Clinker ...	2	14	0
	Fine ash...		16	2
	Old tins, &c.		2	3
		3	13	1

Percentage of residuals ... ... 18·93 per cent.

Test No. 2.—December 28th, 1898.

Duration of test ... ... 3½ hours, 9.30 a.m. to 1 p.m.

State of weather ... ... Very stormy at start, heavy rain.

Nature of refuse ... ... Unscreened ashpit refuse of somewhat better quality than that of December 21st, and containing a fairer proportion of cinders, mixed, however, with a large quantity of waste paper and packing paper of little calorific value.

Total quantity actually burned ... 3 tons 6 cwts 2 qrs 24 lbs = 7,472 lbs.

Steam pressure in boilers at start ... 20 lbs.

Water evaporated from a cold water feed ... ... 350 gallons = 3,500 lbs.

Temperature of feed water ... 50° Fahr.

Refuse burned per lb. of water evaporated ... ... 2·135 lbs.

Water evaporated per lb. of refuse burned ... ... ·46 lbs.

Average steam pressure maintained in each boiler ... ... 54 lbs.

Conditions under which that pressure was maintained ...	Steam jet and oil cremator in use, vertical engine for fan, 25 horse power engine running mortar mill, with exhaust open whole time.
Total indicated horse power per hour developed after allowing, say 30 minutes for raising steam	58½ indicated horse power.

The third test, of three hours duration, was made under somewhat different circumstances, namely, after the cells had been raised to a high temperature, then the heat from the subsequent three hours combustion was sent continuously through the boilers, careful observations being made of the quantity of refuse consumed, and the water evaporated.

TEST NO. 3.—JANUARY 2ND, 1899.

Duration of test	3 hours, 1.45 p.m. to 4.45 p.m.
State of weather	Stormy
Nature of refuse	Unscreened ashpit refuse, very wet, but containing a larger quantity of cinders bits of coal and coke.
Total quantity burned	2 tons 5 cwts. 1 qr. 8 lbs. = 5,076 lbs.
Steam pressure in boilers at start	70 lbs.
Water evaporated	300 gallons = 3,000 lbs.
Temperature of feed water ...	56° Fahr.
Quantity of refuse burned per lb. of water evaporated	1·692 lbs.
Water evaporated per lb. of refuse burned	·59 lbs.
Average steam pressure maintained during three hours (average of 10 readings)	81·2 lbs.
Conditions under which steam pressure was maintained ...	Same as in test of December 28th.

Total indicated horse power maintained as in No. 1 test	50 indicated horse power.

TEST NO. 4.—JUNE 2ND, 1899.

Duration of test	3 hours, 2.30 p.m. to 5.30 p.m.
State of weather	Very fine.
Nature ot refuse	As tabulated on page 140 very light.
Number of men engaged and wages	Three at 3s. 4d. per day of 12 hours (seven days per week), wages of superintendent and man running machinery not taken into account, as revenue from mortar made and sold is sufficient to cover wages.
Total quantity of refuse actually consumed in three hours	5 tons 0 cwts. 2 qrs.= 11,256 lbs.
Quantity of refuse consumed per cell per hour	983 lbs. per cell, or at the rate of upwards of 10 tons per cell per 24 hours.
Cost of burning per ton on the above basis	A fraction over 6d. per ton
Steam pressure in boilers at start	55 lbs.
Average steam pressure maintained during the whole of the three hours, with both engines running the whole time; average of 10 readings	52 lbs.
Total water evaporated from a cold water feed	3,080 lbs.
Total indicated horse power developed per hour, allowing 20 lbs. of water evaporated per indicated horse power	51 indicated horse power.

RESIDUE FROM DESTRUCTOR ANALYSIS BY DR. BERNARD DYER, OF LONDON.

	Ground Clinker.	Flue Dust.
Moisture, organic matter, and water of combination	1·00	6·52
Phosphoric acid	1·06	0·96
Lime	10·47	8·40
Oxide of iron and alumina	33·54	33·34
Carbonic acid, etc.	4·41	10·38
Silicious matter	49·52	40·40
	100·00	100·00
Nitrogen (practically none)		0·17
Equal to ammonia		0·21
Equal to tribasic phosphate of lime ...	2·31	2·09

Torrington 3,436

Totnes 4,100

Sold to farmers at present.

Truro 11,131

Tunbridge Wells 27,885

Now considering.

Tynemouth 46,588

The authorities have just decided to erect a Beaman and Deas Destructor, made by Messrs. Meldrum Brothers, Limited.

Wakefield 38,000

Messrs. Manlove, Alliott and Company erected a destructor here some three years ago. The plant consists of four cells, with patent charging apparatus, and two Babcock and Wilcox Boilers; 160 tons of refuse are dealt with per week.

Wallingford 2,987

Wareham 2,141

Warrington 63,000

Messrs. Manlove, Alliott, and Company erected six cells here in 1889, but they are not now in regular use. A Beaman and Deas Patent Destructor of four cells has been in use for four years past; 13

tons per cell per day are destroyed, at a cost for labour of 9½d. per ton. Particulars of a test made with this plant are here given. Some additional cells are now being erected.

TESTS OF BEAMAN AND DEAS' DESTRUCTOR FURNACE, WARRINGTON INSTALLATION.

(COPY CERTIFIED.)

Date, noon to noon	November 23rd and 24th, 1893.
Duration of trial	24 hours.
Nature of fuel	Unscreened refuse.
Total quantity of fuel burned ...	53,536 lbs=23 tons 18 cwt.
Quantity of fuel per hour ...	2,231 lbs.=19 cwts. 3 qrs.
Total quantity of water evaporated	61,344 lbs.=6,134 galls.
Quantity of water per hour (127 indicated horse power) ...	2,556 lbs.=255 galls.
Weight of clinker produced ...	14,980 lbs.=6 tons 13 cwt.
Per cent. of clinker	27·9
Pressure of steam maintained ...	68 lbs.
Temperature of air in boiler house	45°
Temperature of feed water ..	104° Fahr.
Temperature of gases leaving damper	650° Fahr.
Quantity of water evaporated per lb. of house refuse	1·14
Average temperature by copper wire test	2000° Fahr.
Average air pressure (water) maintained	2½ ins.
Draught velocity in feet per minute	820

(Signed)
GEORGE DARLEY,
Superintendent Ashpit Cleansing Department, Leeds.
GEORGE T. CARTER,
City Engineer's Office, Leeds.

Warwick... 11,903

Wednesbury 25,311

Wells 4,822

Welshpool 6,501

Wenlock... 15,703

West Hartlepool 58,000

Have lately ordered a 6-cell Horsfall Patent Destructor.

West Derby 21,328

Messrs. Manlove, Alliott and Company erected a small destructor several years ago.

Weymouth 21,328

Tipped at present, but a destructor is suggested.

Whitehaven 18,038

Now under consideration.

Extract from report on the disposal of the town's refuse. Whitehaven, October 27th, 1899:—

We will now proceed to give our views, based upon the information with which we have been supplied, on the probable cost of cremating the town's refuse at Whitehaven, as compared with that of conveying it out to sea.

The total quantity of refuse taken out to sea during the year ended on March 31st, 1899, was 12,360 tons. Deducting 1,800 tons of builders' refuse included in that quantity, there remains a balance of 10,560 tons of domestic refuse, road sweepings, offal and garbage, equivalent to an average quantity of about 34 tons for every working day. The cost of disposing of the total quantity of refuse in that way was £448 6s. 0d., but towards that amount the sum of £45 3s. 6d. was received from builders and others, thereby reducing the cost to £403 2s. 6d., which is equivalent to 7·81d. per ton on the total weight.

The Harbour Commissioners now purpose to increase the charge for carrying the refuse out to sea from 6¾d. to 1s. a ton, and other expenses, as at present, will bring the total cost up to 1s. 1d. a ton. The total amount payable, calculated on the total quantity of refuse taken out to sea, will consequently be increased from £408 2s. 6d. to £669 10s. 0d., or 66 %.

Now, the Whitehaven refuse is similar in character to what is consumed and utilised for the generation of steam at the Destructor Works which we visited, and has, therefore, a considerable calorific value. Should a Refuse Destructor be adopted at Whitehaven it would, of course, be in conjunction with the Electric Lighting and Pumping Works at the West Strand, as at Darwen, and the heat produced by it would be utilised for the production of steam at these Works. In fact, our comparison of the two modes of refuse disposal is founded on that assumption.

The fuel value of the refuse cremated at the Works described by us varied, as already stated, from one-fourth to one-seventh of that of good steam coal.

Assuming that Whitehaven refuse was only one-seventh of the value of good steam coal at 9s. a ton, then its commercial or fuel value would be 1s. 3½d. a ton. It takes, however, about one-fifth of the refuse to raise steam for the forced draught in connection with the furnaces of the Destructor. Making allowance for the quantity thus required, the net value of Whitehaven refuse, for steam raising purposes, may fairly be put at 1s. per ton. At that rate the town's refuse alone, viz., 10,560 tons, would be worth £528 per annum.

At all the Destructor Works visited by the deputation, there remained, after cremation, about one-third of the weight of the crude refuse treated. This residue or "clinker" is a hard cinder, and is utilised in various ways, *e.g.*, in forming foundations for new streets, in grinding up with a proper proportion of lime for mortar, etc. In every case its disposal was at least self-supporting.

During the year ended on March 31st last, 1,110 tons of coal, costing £400 11s. 8d., were used at the Electric Lighting Works, West Strand, for Electric Lighting and Pumping purposes. Could the refuse be burnt and utilised, at a regular rate, every working day, it is evident that sufficient power could be produced by the destruction of the quantity of refuse available to run the whole plant without purchasing any coal. That, however, is impracticable in consequence of the varying demand for electric current. On that account, in our opinion, about 500 tons of coal, costing say £250, would probably still be required, during the winter months, to supplement the refuse.

Further, it is obvious that seven tons of refuse will require more stoking than one ton of coal, and, for that reason, we estimate that additional stokers will be required, at an extra charge of £230 per annum.

In regard to Capital Expenditure, it is estimated that a Destructor capable of cremating 40 tons of crude refuse a day of 12 hours, will cost with land, buildings, and new chimney, £5,000, which at 7 % for payment of interest and sinking fund extending over 20 years, will amount to £350 per annum; and that 2 % on £2,500 (the estimated value of the constructive works), equal to £50 per annum, may be taken for repairs and maintenance.

From these data, without taking builders' refuse into calculation, the two modes of disposing of the town's refuse will compare as follows:—

1. CONVEYING AND DEPOSITING AT SEA.

		d.
10,560 tons at 1s. 1d.	= £572 =	13·00 per ton.

2. DESTRUCTOR.

Capital Outlay, £5,000; Interest, 3 %; Annual Repayments of Capital over 20 years, 4%; total, 7 % on £5,000	= £354 =	7·95 per ton.
Additional Labour	= £230 =	5·22 "
Repairs, say 2 % on £2,500	= £50 =	1·13 "
	£630 =	14·30 "
Deduct Estimated Annual Saving of Coal, 610 tons @ 10s.	£305 =	6·90 "
Neit Cost for Destructor	£325 =	7·40 "

Showing that the Destructor is the cheaper method to the extent of £247 per annum, equivalent to a saving of 5·4 pence per ton.

J. L. Paitson (Councillor),
Chairman of the Street and Sanitary Committee.
R. W. Moore (Alderman),
Vice-Chairman of the Street and Sanitary Committee.
Wilson Hastwell (Alderman),
Vice-Chairman of the Water and Lighting Committee.
J. S. Brodie, Borough Engineer.

Widnes 33,000

Partly tipped; remainder sold for manure.

Wilton 2,129

Winchester 19,073

Messrs. Manlove, Alliott and Co. erected one cell here in 1884, and Messrs. Goddard, Massey and Warner a second in 1891. Meldrum patent blowers have since been added to both cells, enabling them to destroy 30 % more refuse than formerly, and produce a better clinker. 80 to 100 tons per week are destroyed at a cost of 10d. per ton for labour.

Windsor 12,327

Have decided upon a 2-cell Horsfall Patent Destructor.

Wisbeach 9,395

Tipped.

Wokingham 3,355

Workington 33,490

Worthing 20,150

Considered in connection with electric lighting, but abandoned.

Wrexham 14,500

The Council have recently ordered a 4-cell Meldrum Patent Simplex Destructor to work in connection with the electric lighting station.

Yeovil 9,648

CHAPTER XIV.

REFUSE DISPOSAL IN URBAN DISTRICT COUNCILS OF ENGLAND AND WALES WITH POPULATIONS OF 2,000 AND UPWARDS.

Abercarn, Monmouthshire	14,000
Aberdare, Glamorganshire	38,218
Abergavenny, Monmouthshire	7,540
Abergele, Denbighshire	2,041
Abersychan, Monmouthshire	15,296
Abertillery, Monmouthshire	16,980
Abram, Lancashire	4,309
Acton, Middlesex (considering)	24,207
Adlington, Lancashire	4,190
Alderley Edge, Cheshire	2,578
Aldershot, Hampshire	25,593

Messrs. Meldrum Bros., Ltd., have a 2-cell Simplex Destructor on order. (This is just now in course of erection.) The power will be used for sewage pumping.

Aleedon, Cumberland	5,697
Alford, Lincolnshire	2,843
Alfreton, Derbyshire	15,355

Considering.

Alnwick, Northumberland	6,746
Altofts, Yorkshire	3,791
Alton, Hampshire	4,671
Altrincham, Cheshire	12,424

The Sanitary Committee were considering in 1898.

Alvaston, Derbyshire	3,116
Amble, Northumberland	2,992
Ambleside, Westmorland	2,360
Ampthill, Bedfordshire	[illegible].294
Annfield Plain, Durham	[illegible]27
Ardsley, East and West, Yorkshire	[illegible]
Ardsley, Yorkshire	

Arnold, Nottinghamshire	... 7,769
Ashbourne, Derbyshire	... 3,810
Ashby-de-la-Zouch, Leicestershire	... 4,535
Ashford Woulds, Leicestershire	... 3,214
Ashford, Kent (considering)...	... 12,000
Ashington, Northumberland	... 9,000
Ashton in Makerfield, Lancashire	... 18,700
Ashton-upon-Mersey, Cheshire	... 4,234
Aspatria, Cumberland	... 2,714
Aspull, Lancashire	... 8,052
Astley Bridge, Lancashire	... 6,234
Aston Manor, Warwickshire	... 68,639

Messrs. Manlove, Alliott and Co. erected 8 cells in 1892. Each cell destroys 6 tons per day at a cost of 7d. per ton burned for labour and materials; a fume cremator is used, fired with breeze. The present cells are inadequate, and much annoyance is caused on account of this; additional cells are badly needed.

Atherton, Lancashire	... 13,720

Under consideration.

Audenshaw, Lancashire	... 7,373
Audley, Staffordshire	... 13,600
Aylesbury, Bucks	... 8,764

Now under consideration in connection with the electric lighting scheme.

Baildon, Yorkshire	... 5,875
Bakewell, Derbyshire	... 2,748
Balby, Yorkshire	... 4,270
Baldock, Hertfordshire	... 2,301
Barking Town, Essex	... 21,000
Barmouth, Merionethshire	... 2,045

Considering in connection with electric lighting.

Barnard Castle, Durham	... 4,341
Barnes, Surrey	... 17,000

Now under consideration.

Barnet, Hertfordshire	... 5,671
Barnoldswick, Yorkshire	... 4,131
Barrowford, Lancashire	... 4,700

Barry, Glamorganshire	31,000
After considering the advisability of erecting a destructor for the past four years, the Council have lately decided to erect cells of the Sterling type.	
Barton-upon-Humber, Lincolnshire	5,226
Battle, Sussex	3,153
Beckenham, Kent	25,000
The Horsfall Destructor Co., Ltd., have 3 cells in hand at present.	
Bedlington, Northumberland	25,000
Bedwellty, Monmouthshire	6,553
Beeston, Nottinghamshire	6,448
Belper, Derbyshire	10,420
Benfieldside, Durham	6,359
Benwell, Northumberland	10,501
Bethesda, Carnarvonshire	5,799
Bexhill, Sussex	10,000
Now under consideration.	
Bexley, Kent	12,200
Bicester, Oxfordshire	3,343
Biddulph, Staffordshire	5,290
Biggleswade, Bedfordshire	4,943
Billings, Lancashire	3,936
Bilston, Staffordshire	23,451
Bingley, Yorkshire	18,500
Birkdale, Lancashire (considering)	12,386
Birkenshaw, Yorkshire	2,500
Bishop Auckland, Durham	10,527
Now considering.	
Bishop Stortford, Hertfordshire	6,594
Blackrod, Lancashire	4,021
Blaenavon, Monmouthshire	11,454
Blaydon, Durham	13,371
Bognor, Sussex	4,096
Bollington, Cheshire	3,913
Bowdon, Cheshire	2,792
Bowness, Westmorland	2,062
Bradford-on-Avon, Wiltshire	4,957
Braintree, Essex	5,203
Brampton, Derbyshire	2,650

Brandon, Durham	... 14,329
Branksome, Dorsetshire	... 6,608
Bredbury, Cheshire	... 5,821
Brentford, Middlesex	... 13,726
The Council recently decided to erect cells of the Fryer type by Messrs. Manlove, Alliott and Co., Ltd.	
Bridgend, Glamorganshire	... 4,759
Bridlington, Yorkshire	... 8,916
Now under consideration.	
Brierfield, Lancashire	... 8,000
Brierley Hill, Staffordshire	... 11,831
Brigg, Lincolnshire	... 2,990
Brightlingsea, Essex	... 3,920
Briton Ferry, Glamorganshire	... 5,778
Brixham, Devonshire	... 6,224
Broadstairs, Kent	... 7,500
Bromborough, Cheshire	... 2,482
Bromley, Kent	... 21,685
Now under consideration. Local brickmakers offered £800 for one year's refuse; this would equal one penny reduction in the rate.	
Bromsgrove, Worcestershire	... 7,934
Broughton, Lincolnshire	... 1,255
Brownhills, Staffordshire	... 11,652
Brumby, Lincolnshire	... 2,140
Brynmawr, Brecknockshire	... 6,330
Buckfastleigh, Devonshire	... 2,700
Buckhurst Hill, Essex	... 4,130
Burgess Hill, Sussex	... 4,145
Burley, Yorkshire	... 2,661
Burnham, Somersetshire	... 2,413
Buxton, Derbyshire	... 8,900
A 4-cell Fryer Destructor was erected in 1886, which deals with 100 tons per week at a cost of 8d. per ton. The plant was extended in 1897.	
Caerphilly, Glamorganshire	... 14,000
Calverley, Yorkshire	... 2,525
Camborne, Cornwall	... 14,703
Cannock, Staffordshire	... 20,613
Carlton, Nottinghamshire	... 7,500

Carnforth, Lancashire	2,680
Carshalton, Surrey	6,000
Castleford, Yorkshire	17,000
Castleton, Lancashire	4,857
Caversham, Oxfordshire	4,966
Chadderton, Lancashire	22,087
Charlton Kings, Gloucestershire	2,687
Chatteris, Cambridgeshire	4,587
Cheadle, Cheshire	8,252
Chepstow, Monmouthshire	3,378
Chertsey, Surrey	11,298
Chesham, Buckinghamshire	8,018
Cheshunt, Hertfordshire	11,000
Now under consideration; the majority is at present taken by a local brickmaker.	
Chesterton, Cambridgeshire	7,526
Chingford, Essex	2,737
Chiswick, Middlesex	27,000
Church, Lancashire	5,870
Now considering.	
Cirencester, Gloucestershire (considering)	7,521
Clacton, Essex	6,000
Claycross, Derbyshire	7,727
Clayton, Yorkshire	4,707
Clayton-le-Moors, Lancashire	7,155
Cleator Moor, Cumberland	9,461
Cleckheaton, Yorkshire	11,826
Now under consideration; an early decision in favour of a destructor is likely.	
Cleethorpes, Lincolnshire	4,306
Under consideration.	
Clevedon, Somersetshire	5,703
Coalville, Leicestershire	12,000
Cockermouth, Cumberland	5,500
Coleford, Gloucestershire	2,450
Colwyn Bay, Denbighshire	4,750
Under consideration.	
Consett, Durham	8,175
Cosely, Staffordshire	21,899

Cottingham, Yorkshire	3,820
Cowes, Isle of Wight	7,768
Now under consideration; much annoyance has been caused by tipping.	
Cowpen, Northumberland	12,969
Cramlington, Northumberland	5,987
Crediton, Devonshire	4,361
Crewkerne, Somersetshire	2,000
Cromer, Norfolk	2,197
Under consideration for some time past.	
Crompton, Lancashire	12,901
Now under consideration.	
Croston, Lancashire	2,134
Crowle, Lincolnshire	3,179
Dalton-in-Furness, Lancashire	13,300
Darfield, Yorkshire	3,416
Darlaston, Staffordshire	14,422
Dartford, Kent	13,378
Darton, Yorkshire	7,013
Dawley, Shropshire	6,996
Dawlish, Devonshire	4,210
Denby, Yorkshire	3,164
Denholme, Yorkshire	3,237
Denton, Lancashire	15,000
Now under consideration; a destructor is favoured.	
Desborough, Northamptonshire	2,900
Diss, Norfolk	3,963
Dodworth, Yorkshire	3,106
Dolgelly, Merionethshire	2,467
Dorking, Surrey	7,132
Under consideration.	
Downham, Norfolk	2,537
Drightlington, Yorkshire	4,322
Dronfield, Derbyshire	3,438
Droylsden, Lancashire	9,481
Dukinfield, Cheshire	20,000
Ealing, Middlesex	32,000

This being the first destructor to achieve any success in the London district, a few particulars will be of interest. The first cells, of the Fryer type, were erected in 1883; these were extended in 1885 and 1889. Here it was that the Jones Fume Cremator first saw the light, but, as Mr. Jones has recently tried some high temperature cells, possibly this will not be used much more. Under the old conditions, about 4½ tons was consumed per cell per day, but this was a mixture of refuse and sewage sludge. The total cost of burning, including repayment of loan, is said to be 1s. 6d. per ton.

East Barnet, Middlesex	7,712
East Cowes, Isle of Wight	2,880
East Dereham, Norfolk	5,524
East Ham, Essex	7,000
Eastleigh, Hampshire	8,000
East Stonehouse, Devonshire	15,504
Eastwood, Nottinghamshire	4,363
Ebbw Vale, Monmouthshire	17,000
Eccleshill, Yorkshire	7,928
Edmonton, Middlesex	25,381
Egremont, Cumberland	6,258
Elland, Yorkshire	9,991
Ely, Cambridgeshire	8,017
Enfield, Middlesex (considering)	31,532
Epping, Essex	3,000
Epsom, Surrey	8,417
Now under consideration.	
Erdington, Warwickshire	9,628
Erith, Kent	17,000
Esher, Surrey	3,855
Now under consideration.	
Eston, Yorkshire	10,695
Eton, Buckinghamshire	2,489
Exmouth, Devonshire	8,094
Failsworth, Lancashire	13,500
Fairfield, Derbyshire	2,103
Far Cotton, Northamptonshire	2,252
Fareham, Hampshire	7,934
Farnborough, Hampshire	8,071
Farnham, Surrey	5,545

Farnworth, Lancashire 26,000

A comparatively new type of destructor is in use here, best known as the "Bennett Phythian," now being sold by Messrs. Heenan & Froude, Ltd., Manchester. This destructor is fully described elsewhere and illustrated. The figures of a test are here shown.

WORKING TESTS OF HEENAN'S "TWIN CELL" DESTRUCTOR AT FARNWORTH.

No. 1.—DATE : JUNE 21ST, 1899.

Duration	3½ hours
Total weight of refuse burnt	5,880 lbs.
Weight of refuse burnt per hour	1,680 lbs.
Weight of refuse burnt per sq. ft. of grate per hour	42 lbs.
Total water evaporated from 58° Fahr. at 120 lbs. per sq. inch	6,500 lbs.
Water evaporated per hour at 120 lbs. per sq. inch	1,857 lbs.
Weight of water evaporated per lb. of refuse at 120 lbs. per sq. inch	1·10 lbs.
Clinker	25 per cent.
Moisture	24 per cent.

No. 2.—DATE : JUNE 22ND, 1899.

Duration	5½ hours
Weight of refuse burned	8,232 lbs.
Total weight of refuse burned per hour	1,497 lbs.
Weight of refuse burned per sq. ft. of grate per hour	37½ lbs.
Total water evaporated from 58° Fahr. at a pressure of 120 lbs. per sq. inch	9,400 lbs.
Weight of water evaporated per hour at 120 lbs. pressure	1,710 lbs.
Weight of water evaporated per lb. of refuse at 120 lbs. per sq. inch	1·13 lbs.
Clinker	25 per cen
Moisture	26½ per cen

No. 3.—Date : August 11th, 1899.

Duration	4¼ hours
Total weight of refuse burned	5,040 lbs
Weight of refuse burned per hour	1,186 lbs.
Weight of refuse burned per sq. ft. of grate per hour	29·5 lbs.
Total water evaporated from 60° Fahr. at 120 lbs. per sq. inch pressure	7,500 lbs.
Water evaporated per hour at 120 lbs. per sq. inch	1,785 lbs.
Water evaporated per lb. of refuse at 120 lbs. per sq. inch...	1·48 lbs.
Clinker	15 per cent.
Moisture	10 per cent.

Test No. 1 was with a fair average sample of ashpit refuse.

Test No. 2 was with a wet sample of refuse.

Test No. 3 was with a dry sample of refuse.

That the refuse for No. 3 Test was phenomenally good, is proved by the percentage of clinker and moisture.

Farsley, Yorkshire...	5,328
Featherstone, Yorkshire	7,528
Felixstowe, Suffolk	2,507

Considering shortly.

Felling, Durham	20,000
Fenny Stratford, Buckinghamshire	3,341
Fenton, Staffordshire	16,998

Now considering.

Festiniog, Merionethshire	11,073
Filey, Yorkshire	2,481
Finchley, Middlesex	9,000
Finedon, Northamptonshire	3,197
Fleetwood, Lancashire	9,274

Two cells of the Beaman and Deas type are now being completed here ; Babcock and Wilcox Boilers are also being put down in connection with same. Messrs. Meldrum Brothers, Limited, are completing this contract as purchasers of Beaman and Deas patents.

TEST OF BEAMAN & DEAS DESTRUCTOR AT THE ELECTRIC LIGHT STATION, FLEETWOOD *(Carried out by Meldrum Brothers, Limited, Engineers, Manchester, in conjunction with Messrs. Medhurst and Lloyd, Consulting Engineers, 13, Victoria Street, Westminster, S.W.)*

Date of test	September 28th, 1900
Duration of test	8 hours
State of weather	Fine
Kind of fuel	Unscreened ashpit refuse (very wet.)
Number of cells	Two
Area of each grate	25 square feet
Type of boiler...	Babcock and Wilcox
Heating surface of boiler ...	1,426 square feet
Total weight of fuel burned ... 14 tons 7 cwt. 2 qr. 20 lbs. ...	32,220 lbs.
Weight burned per hour ... 1 ton. 15 cwt. 3 qr. 23 lbs. ...	4,027 lbs.
Weight burned per square foot grate per hour 50 square feet. ...	80·5 lbs.
Total weight of clinker and ash, 4 ton 15 cwt. 1 qr.	10,444 lbs.
Percentage of clinker and ash ...	32·4 per cent.
Total water evaporated	31,952 lbs.
Water evaporated per hour ...	3,994 lbs.
Water evaporated per lb. of refuse, actual	·9,916 lbs.
Water evaporated per lb. of refuse from and at 212° Fahr. including economiser	1·191 lbs.
Water evaporated per square foot heating surface	2·8 lbs.
Temperature of water at tank ...	59° Fahr.
Temperature of feed water from economiser	239° Fahr.
Average steam pressure... ...	135 lbs.
Average air pressure, under grates	2½ inches
Temperature of combustion chamber by copper test	2000° Fahr.

Temperature in main flue, before economiser	622° Fahr.
Temperature in main flue, after economiser	356° Fahr.
Average chimney pull	⅜ inch.

It rained heavily on three consecutive days immediately preceding the test, and quality of refuse was exceedingly bad.

Friern Barnet, Middlesex	11,500
Frimley, Surrey	5,295
Now under consideration, in connection with electric lighting scheme.	
Frome, Somersetshire	9,613
Fulwood, Lancashire	4,112
Gainsborough, Lincolnshire	19,540
Garston, Lancashire	16,000
Now under consideration ; much delayed owing to opposition to proposed site.	
Gildersome, Yorkshire	3,175
Gillingham, Kent	27,813
Glemsford, Suffolk	2,375
Glyncorrwg, Glamorganshire	3,622
Golborne, Lancashire	7,000
Golcar, Yorkshire...	9,108
Gomersal, Yorkshire	3,923
Goole, Yorkshire	15,413
Gorton, Lancashire	25,000
Now under consideration.	
Gosforth, Northumberland...	6,674
Gosport, Hampshire	25,438
Now under consideration.	
Grays Thurrock, Essex	13,500
The Council here have recently contracted with Messrs. Meldrum Bros., Limited, to erect a 3-cell Simplex Patent Destructor and Lancashire Boiler to work in connection with electric light works.	
Greasborough, Yorkshire	3,217
Great Crosby, Lancashire	6,400
Great Driffield, Yorkshire	5,703
Great Harwood, Lancashire	12,000
Now under consideration.	

Greetland, Yorkshire	5,623
Guiseley, Yorkshire	4,079
Guisborough, Yorkshire	5,623
Hadleigh, Suffolk	3,329
Halstead, Essex	6,056
Hampton, Middlesex	5,822

Under consideration in connection with proposed electric lighting.

Handsworth, Staffordshire	32,756

Messrs. Goddard, Massey and Warner have an 8-cell destructor in hand at present.

Handsworth, Yorkshire	10,295
Hanwell, Middlesex	6,850
Harrington, Cumberland	3,535
Harrow, Middlesex	5,725
Havant, Hampshire	3,468
Haverhill, Suffolk	4,587
Haydock, Lancashire	6,535
Haywards Heath, Sussex	2,452
Heage, Derbyshire	2,490
Heanor, Derbyshire	2,279
Heath Town, Staffordshire	7,075
Heaton Norris, Lancashire	7,164
Heavitree, Devonshire	7,500
Hebburn, Durham	22,650
Hebden Bridge, Yorkshire	6,365
Heckmondwike, Yorkshire	11,000

Messrs. Manlove, Alliott and Co. erected a 3-cell Fryer Destructor in 1889, to which Horsfall's Patent Forced Draught was added in 1893. The Horsfall Destructor Company, Limited, have two cells on order at present.

Hendon, Middlesex	15,385

Now under consideration.

Herne Bay, Kent	3,829
Heston, Middlesex	29,185
Hetton, Durham	12,726
Hexham, Northumberland	5,945
Hinckley, Leicestershire	9,638
Hinderwell, Yorkshire	2,031

Hindley, Lancashire	22,000

Now under consideration.

Hipperholme, Yorkshire	3,309
Hitchin, Hertfordshire	8,860
Hoddesdon, Hertfordshire	3,976
Holbeach, Lincolnshire	4,771
Hellingworth, Cheshire	2,395
Holme Cultram, Cumberland	4,602
Holmfirth, Yorkshire	9,500
Holyhead, Anglesey	8,736
Holywell, Flintshire	3,018
Honley, Yorkshire	5,466
Hoole, Cheshire	3,662
Horbury, Yorkshire	5,673
Horncastle, Lincolnshire	4,374
Hornsea, Yorkshire	2,013
Hornsey, Middlesex	72,500

Here is a 12-cell destructor erected by Messrs. Goddard, Massey and Warner. Each cell deals with eight tons per 24 hours at a total cost per ton of 1s. 8d. to 1s. 10d. Owing to the difficulty of getting rid of the trade refuse, it has recently been decided to add forced draught to the whole of the cells at a cost of £750.

Horsforth, Yorkshire	7,574
Horsham, Sussex	8,637
Horwich, Lancashire	12,850
Houghton-le-Spring, Durham	7,202
Hoylake, Cheshire	9,525
Hoyland Nether, Yorkshire	11,006
Hucknall Torkard, Nottinghamshire	16,000
Hucknall-under-Huthwaite, Nottinghamshire	3,113
Hunstanton, Norfolk	1,322

It would be audacity to say much about such a very small place as Hunstanton, if the unique distinction did not belong to it of being the smallest town in the world to instal a Destructor and Power plant.

A further bold departure has also been made in this case, and that is to combine a Refuse Destructor with a Water Pumping Station. Three and a half

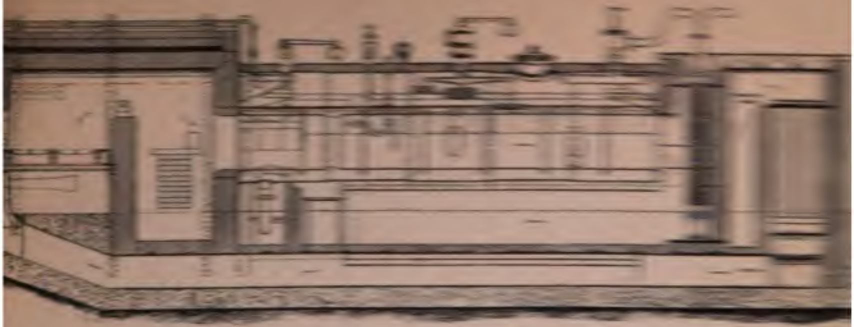


FIG. 25.—SECTIONAL VIEW, MELDRUM'S DESTRUCTOR AT HUNSTANTON.

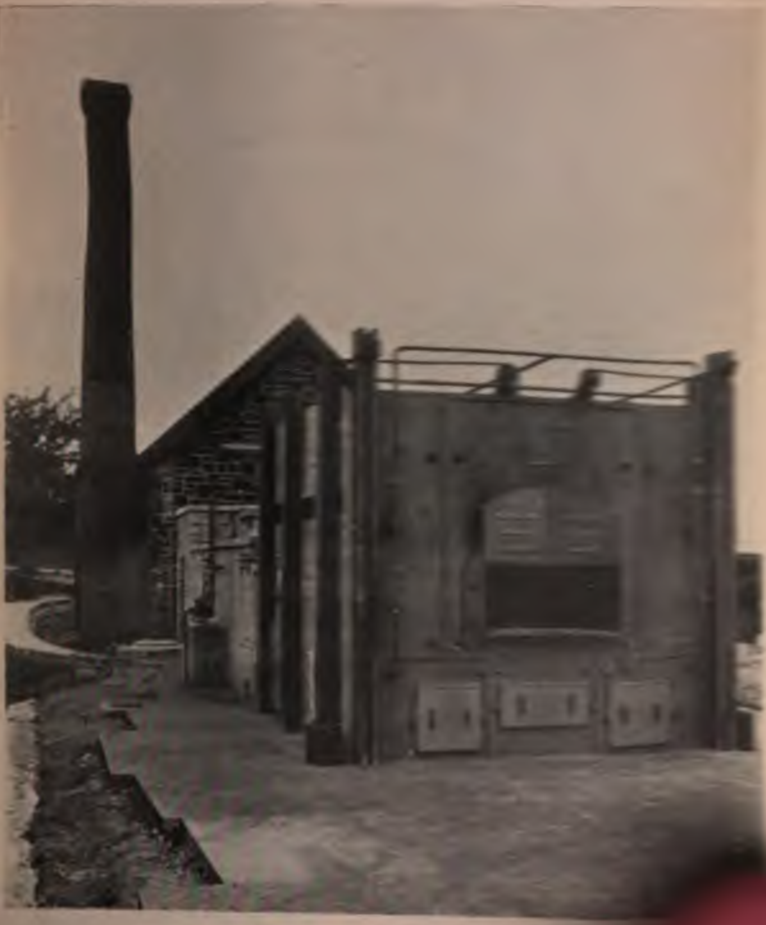


FIG. 26.—MELDRUM'S "SIMPLEX" DESTRUCTOR AT HUNSTANT

face page 102.)

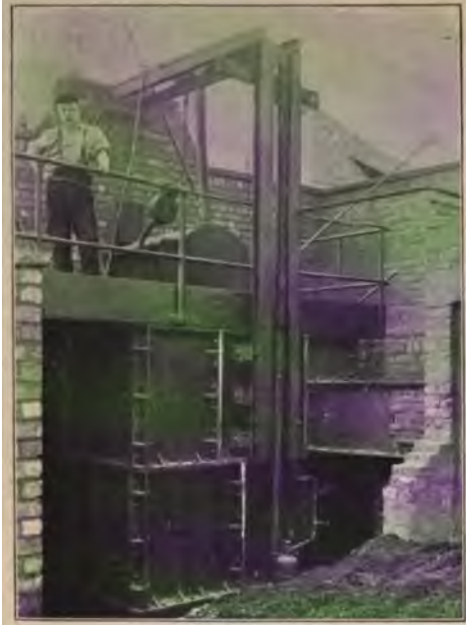


FIG. 27

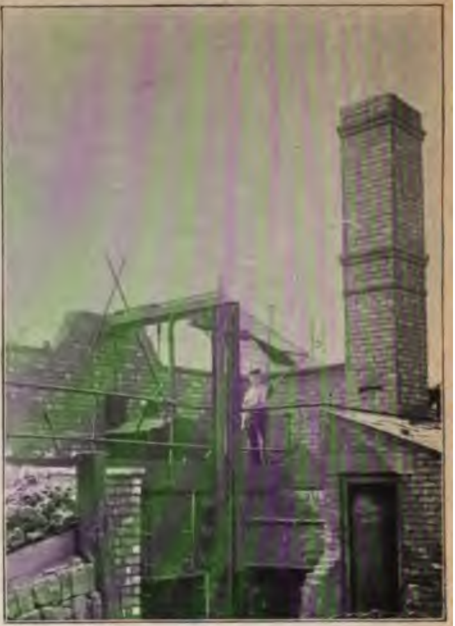


FIG. 28.

TWO VIEWS OF MASON'S REFUSE GASIFIER AT MOSS SIDE.

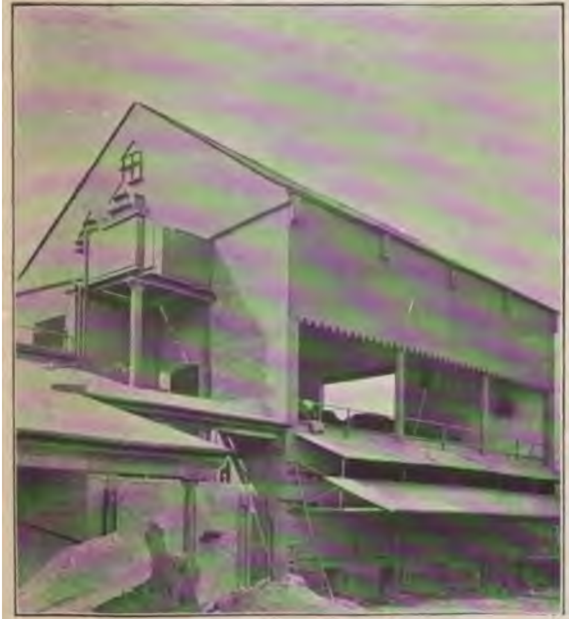


FIG. 29.

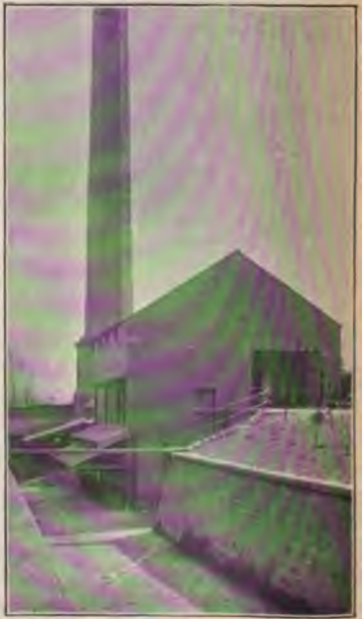


FIG. 30.

TWO VIEWS OF MASON'S REFUSE GASIFIER AT WITHINGTON.

tons of refuse per day, burned at the rate of half a ton per hour, suffices to provide sufficient steam to pump the town's water supply each day.

Although small the plant is complete in every detail. Under the supervision of Messrs. Stevenson & Burstall, Consulting Engineers, Westminster, Messrs. Meldrum Brothers, Limited, erected their Destructor and Cornish Boiler, as shown in plan and illustration. Figs. 25 and 26. The working pressure of the boiler is 100 lbs. per square inch, and in connection with same a Schwoerer Superheater is employed to increase the temperature and ensure dryness.

My excuse for introducing this installation so prominently, is merely to show that even towns of such insignificant size as this can actually make the destruction of their refuse a profitable transaction; and further, that, providing due care is taken to prevent contamination, there is no reason why refuse should not be employed to raise power for water pumping.

Hurst, Lancashire...	6,772
Hayton, Lancashire	4,625
Idle, Yorkshire	7,818
Ilford, Essex	10,913
Was under consideration in connection with electric lighting, but abandoned.	
Ilfracombe	8,500
Now under consideration.	
Ilkley, Yorkshire	5,657
Ince, Lancashire	21,736
Irlam, Lancashire	7,000
Kearsley, Lancashire	7,993
Kettering, Northamptonshire	19,454
Under consideration.	
Kempston, Bedfordshire	4,000
Kenilworth, Warwickshire	4,173
Keswick, Cumberland	3,905
Kidsgrove, Staffordshire	3,801

Kingsbridge, Devonshire	2,885
Now under consideration.	
Kingsthorpe, Northamptonshire	7,691
Kingswood, Gloucestershire	9,114
Kingston, Herefordshire	2,086
Kirkburton, Yorkshire	3,152
Kirkby-in-Ashfield, Nottinghamshire	6,533
Kirkham, Lancashire	3,995
Kirkheaton, Yorkshire	2,632
Kirkleatham, Yorkshire	4,209
Knaresborough, Yorkshire	4,649
Knottingley, Yorkshire	5,500
Knutsford, Cheshire	4,643
Latham, Lancashire	6,798
Leadgate, Durham	4,456
Leatherhead, Surrey	4,305
Ledbury, Herefordshire	3,091
Leek, Staffordshire	15,000
Under consideration last year.	
Lees, Lancashire	3,877
Leigh, Lancashire	3,700
Now under consideration.	
Leighton Buzzard, Bedfordshire	6,704
Leiston, Suffolk	3,600
Lepton, Yorkshire	2,855
Levenshulme, Lancashire	10,000
Now under consideration.	
Leyland, Lancashire	5,972
Leyton, Essex	90,000

About six years ago Messrs. Beaman and Deas, Limited, erected an 8-cell destructor and two Babcock and Wilcox Boilers. This installation has been successful, and has aroused considerable interest, as it was the first place where pressed sewage sludge cake was burned on a large scale. Each cell has to deal with 16 tons per day, which is a mixture, two-thirds of refuse to one-third of sludge. The cost per ton destroyed is 1s. 7d.

TEST AT LEYTON BY SIR DOUGLAS FOX, M.I.C.E., AND FRANCIS FOX, ESQ., M.I.C.E., APRIL, 1897, STEAM-RAISING VALUE OF THE REFUSE AND SEWAGE CAKE.

Duration of trial, 10 a.m. to 10 p.m., March 30th, 1897	12 hours
Number of cells of destructor in use	4

DETAILED RESULTS OF TRIAL.

	Tons.cwts.qrs.	lbs.
Weight of house refuse consumed ...	22 5 0	=49,840
Weight of sewage cake consumed ...	11 4 1	=25,116
Total weight of material burnt ...	33 9 1	=74,956
Total weight of clinker produced ...	9 16 2	=22,008
Proportion of house refuse to sewage cake	100 to 50·4=2 to 1 (nearly.)	
Average weight of material burnt per cell per hour	1,561 lbs.	
Proportion of clinker produced to material burnt	29·4. per cent.	
Average steam pressure in boilers ...	105 lbs.	
Average temperature of feed water ...	65° Fahr.	
Weight of water evaporated	3,192 gals.= 31,920 lbs.	
Weight of water evaporated per hour...	2,660 lbs.	
Weight of water evaporated per lb. of material burnt	0·426 lbs.	

CORRESPONDING WITH

Weight of water evaporated per lb. of material burnt from and at 212° Fahr.	0·507 lbs.
Average pressure of air in ashpit ...	2 in. of water.

PERCENTAGE OF MOISTURE IN SEWAGE SLUDGE.

	Water per cent.
Sample A	61·23
Sample B	68·50
Average	64·86.

The extremely low quality of the material consumed (poor house refuse and wet sewage cake) is indicated by the small quantity of water evaporated per lb. of fuel (0·426 lbs.) In spite of this, the total power produced was considerable. Taking the total weight of water evaporated as 31,920 lbs., and assuming an average consumption of 20 lbs. of water per indicated horse power, the horse power available would be 133 indicated horse power; the equivalent amount of steam coal which would be required to obtain this result is 1¾ tons, representing a cost of £1 11s. 6d., assuming the price of coal to be 18s. per ton, delivered at the works.

The total heat available was more than sufficient to heat the boilers, and these, in their turn, supplied more steam than was required for the needs of the works, which was served by a 45 horse power engine in the sewage works, and by a 12 horse power engine in the portion occupied by the destructors. A smaller engine drove two fans delivering air to the ashpits of the cells, a dynamo lighting the works, and a steam hoist for raising the sewage to the charging floor, and a feed-water pumping engine was also provided with steam from the boilers. The larger engine drove a pump lifting sewage from low to high level, an air compressor for the filter press, and all minor plant in the sewage works.

Linthwaite, Yorkshire	6,666
Litherland, Lancashire	4,441
Littleborough, Lancashire	10,878
Little Hulton, Lancashire	7,278
Littlehampton, Sussex	4,452
Little Lever, Lancashire	5,468
Liversedge, Yorkshire	13,669
Under consideration.	
Llandudno, Carnarvonshire...	7,348
Here a 4-cell Beaman and Deas Patent Destructor with Babcock and Wilcox Boilers was erected about two years ago to work in connection with the electric lighting station.	
Llanelly, Carmarthenshire	27,000
Llanfairfechan, Carnarvonshire	2,407
Llanfrecha, Carnarvonshire...	2,780
Llangollen, Denbighshire	3,225

Llantarnam, Monmouthshire	4,905
Loftus, Yorkshire	6,208
Long Eaton, Derbyshire	9,636
Longridge, Lancashire	4,101
Long Sutton, Lincolnshire	2,439
Lower Beddington, Cheshire	5,069
Luddenden Foot, Yorkshire	3,142
Ludgvan, Cornwall	2,334
Lymm, Cheshire	4,995
Lytham, Lancashire	4,656
Now under consideration (since decided)	
Madron, Cornwall...	2,755
Maesteg, Glamorganshire	9,417
Malden, Surrey	3,437
Malton, Yorkshire...	4,910
Malvern, Worcestershire	8,107
Under consideration	
Malvern Link, Worcestershire	4,600
Mansfield Woodhouse, Nottinghamshire	2,819
March, Cambridgeshire	6,995
Margam, Glamorganshire	8,000
Market Harborough, Leicestershire	5,876
Now under consideration	
Market Rasen, Lincolnshire...	2,497
Marple, Cheshire	4,844
Marsden, Yorkshire	3,855
Marlow, Buckinghamshire	3,900
Maryport, Cumberland	12,536
Masham, Yorkshire	2,224
Matlock, Derbyshire	2,285
Melksham, Wiltshire	2,073
Meltham, Yorkshire	4,761
Melton Mowbray, Leicestershire	6,740
Merthyr Tydvil, Glamorganshire	70,811
The council recently decided to make a trial of Mason's Gasifier, made by Messrs. W. F. Mason, Ltd., of Manchester.	
Methley, Yorkshire	4,357

Mexborough, Yorkshire	7,734

Have recently decided to erect a Meldrum Patent Simplex Destructor.

Middlewich, Cheshire	3,850
Midgley, Yorkshire	2,865
Midsomer Norton, Somersetshire	5,041
Milford Haven, Pembrokeshire	4,500
Millom, Cumberland	10,000
Milnrow, Lancashire	9,660
Milton, Kent	5,213
Mirfield, Yorkshire	12,600
Mold, Flint	4,457
Monk Bretton, Yorkshire	3,426
Morecambe, Lancashire	11,015

Messrs. Hughes and Stirling now have some cells in hand for this council.

Moss Side, Lancashire	26,000

Have a Mason's Gasifier at work (Figs. 27 and 28), the first erected, particulars of tests made with same are here given. A contract has recently been placed with the Horsfall Destructor Co.

TEST MADE WITH A MASON'S REFUSE GASIFIER AT THE YARD OF THE MOSS SIDE URBAN DISTRICT COUNCIL.

Date of test	August 21st and 22nd, 1899
Duration of test	24 hours
Sectional area of cell ...	6 ft. 3 in. × 5 ft. = 31·25 sq. ft.
Area of grate	16 sq. ft.
Kind of fuel	...Unscreened ashpit refuse
Percentage of Moisture	30·3 per cent
Total weight of refuse burned	13,552 lbs.
Weight of refuse burned per hour	565 lbs.
Weight burned per sq. ft. of grate per hour ...	35·25 lbs.
Pressure in boiler supplying steam to jet blower	... 60 lbs.
Weight of steam used for jet blower per hour...	140 lbs.
Pressure of forced draught under grate	2½ ft. water column
Percentage of residue, clinker, and ...	25 per cent.
Smoke from chimney	... none

ANALYSIS OF GASES FROM GASIFIER.

	Per Cent.
Carbon dioxide (CO_2)	13·0
Carbon monoxide (CO)	10·0
Oxygen	2·4
Hydrocarbons (C_2H_4)	1·6
Hydrogen	13·6
Nitrogen	59·2
	99·8

GASES FROM BASE OF CHIMNEY.

(Average of Two Analyses).

	Per Cent.
Carbon dioxide (CO_2)	11·5
Carbon monoxide (CO)	1·9
Oxygen	4·6
Hydrocarbons (C_2H_4)	1·3
Hydrogen	2·0
Nitrogen	78·7
	100·0

Mottram, Cheshire	3,270
Mountain Ash, Glamorganshire	31,000

Under consideration, an evaporative test with some of their refuse showed a remarkable calorific value.

Much Woolton, Lancashire	4,545
Mytholmroyd, Yorkshire	5,498
Nailsworth, Gloucestershire	3,065
Nantwich, Cheshire	7,412
Nantyglo, Monmouthshire	12,410
Neston, Cheshire	3,597
Newbold, Derbyshire	5,077
Newburn, Northumberland	7,963
Newhaven, Sussex	6,000
Newmarket, Cambridgeshire	8,631

Recently decided to erect a destructor.

New Mills, Derbyshire	7,900

New Mill, Yorkshire	5,044
Considered in September 1898.	
Newport, Shropshire	3,545
Newquay, Cornwall	2,040
The Medical Officer of Health has strongly recommended a destructor, but nothing has yet been done.	
Newton Abbott, Devonshire	8,525
Newton, Lancashire	6,632
Newtown, Montgomery	6,610
Norden, Lancashire	3,955
Normanton, Yorkshire	10,234
Northallerton, Yorkshire	3,802
Northam, Devonshire	5,043
North Brierley, Yorkshire	22,178
North Bromsgrove, Worcestershire	5,072
North Darnley, Derbyshire...	2,179
Northfleet, Kent	11,717
Northowran, Yorkshire	3,013
North Walsham, Norfolk	3,612
Nuneaton, Warwickshire	15,246
Under consideration	
Oakworth, Gloucestershire	5,870
Ogmore, Glamorganshire	17,000
Considering.	
Oldbury, Worcestershire	24,000
Tipped.	
Ormesby, Yorkshire	8,620
Ormskirk, Lancashire	6,298
Orrell, Lancashire...	4,914
Oswaldwistle, Lancashire	15,000
Otley, Yorkshire	7,388
Ottery St. Mary, Devonshire	3,855
Oundle, Northamptonshire	2,680
Oxenhope, Yorkshire	2,475
Oystermouth, Glamorganshire	3,675
In 1898 the Surveyor prepared a report but no move has yet been made.	
Padiham, Lancashire	11,311
The Horsfall Destructor Company, Ltd., now have some cells in hand for this Council.	

Paignton, Devonshire	... 6,783
Panteg, Monmouthshire	... 6,319
Paul, Cornwall	... 5,691
Pemberton, Lancashire	... 22,000
Penarth, Glamorganshire	... 13,500
The Medical Officer of Health has strongly advocated a destructor.	
Penistone, Yorkshire	... 2,553
Penmaenmawr, Carmarthenshire	... 2,710
Penrith, Cumberland	... 8,981
Perry Barr, Staffordshire	... 2,310
Petersfield, Hampshire	... 2,480
Phillack, Cornwall...	... 4,099
Pickering, Yorkshire	... 3,676
Pocklington, Yorkshire	... 2,577
Pokesdown, Hampshire	... 2,266
Pontypool, Monmouthshire...	... 6,000
Pontypridd, Glamorganshire	... 36,000
Considering.	
Portishead, Somersetshire	... 2,700
Portland, Dorsetshire	... 9,541
Prescot, Lancashire	... 6,745
Prestwich, Lancashire	... 11,500
Pudsey, Yorkshire...	... 14,585
Now under consideration	
Quarry Bank, Staffordshire...	... 6,732
Queensbury, Yorkshire	... 6,740
Radcliffe, Lancashire	... 25,025
The Council have lately placed contract with Messrs. Meldrum Bros., Ltd., for a Simplex Patent Destructor.	
Radstock, Somersetshire	... 3,439
Rainford, Lancashire	... 3,472
Ramsbottom, Lancashire	... 16,725
Now under consideration.	
Ramsey, Hampshire	... 4,684
Ravensthorpe, Yorkshire	... 5,134
Considered in 1897, but abandoned.	
Rawmarsh, Yorkshire	... 14,500
Redcar, Yorkshire	... 2,818

Reddish, Lancashire	6,854
Redruth, Cornwall	10,324
Rhyl, Flintshire	7,000
Some Fryer cells erected by Messrs. Manlove, Alliott and Co., have been working here for some years past.	
Rhondda, Glamorganshire	110,626
Messrs. W. F. Mason, Ltd., of Manchester, now have an order in hand for one of their refuse gasifiers.	
Rhymney, Monmouthshire	7,733
Ripley, Derbyshire	8,774
Risca, Monmouthshire	7,780
Rishton, Lancashire	7,800
Romford, Essex	8,408
Ross, Herefordshire	3,575
Now under consideration.	
Rothwell, Northamptonshire	3,375
Rothwell, Yorkshire	10,605
Rowley Regis	34,500
Royton, Lancashire	15,000
Messrs. Goddard, Massey and Warner erected a 4-cell destructor in 1893. Three cells only are fired at a time, and the consumption per cell is 4 to 5 tons ; the cost per ton destroyed is 9½d. for labour. A cremator is used occasionally fired with oil jets.	
Rugby, Warwickshire	11,262
Rugeley, Staffordshire	4,181
Runcorn, Cheshire	20,050
Under consideration.	
Rushden, Northamptonshire	7,442
Ryton, Durham	6,700
St. Annes-on-Sea, Lancashire	2,538
Messrs. Goddard, Massey and Warner are at present erecting a small destructor here.	
St. Austell, Cornwall	3,477
St. Helens, Isle of Wight	4,469
St. James, Northamptonshire	4,089
St. Mary Church, Devonshire	6,653
Under consideration.	

St. Neots, Hampshire	4,077
St. Thomas Apostle, Devonshire	8,240
Sale, Cheshire	9,644
The Nuisance Committee have the matter before them.	
Saltburn-on-Sea	2,232
Sandal Magna, Yorkshire	5,082
Sandbach, Cheshire	5,283
Sandown, Isle of Wight	5,020
Scunthorpe, Lincolnshire	3,415
Seaford, Sussex	3,200
Seaham Harbour, Durham	8,856
Sedgley, Staffordshire	4,961
Seghill, Northumberland	2,269
Selby, Yorkshire	6,187
Sevenoaks, Kent	7,610
Shanklin, Isle of Wight	4,461
Sheerness, Kent	13,481
Now under consideration.	
Shelf, Yorkshire	2,612
Shepshed, Leicestershire	4,416
Shepton Mallet, Somersetshire	5,501
Sherborne, Dorsetshire	3,741
Shildon, Durham	9,537
Now under consideration.	
Shipley, Yorkshire	23,387
Messrs. Meldrum Bros., Ltd., have just lately completed a 4-cell Simplex Destructor for this Council.	
Shoeburyness, Essex	2,990
Shoreham, New, Sussex	3,393
Short Heath, Staffordshire	2,514
Sidmouth, Devonshire	3,478
Silsden, Yorkshire	3,866
Sittingbourne, Kent	8,302
Considering.	
Skelmanthorpe, Yorkshire	3,390
Skelmersdale, Lancashire	6,627
Skelton, Yorkshire	11,842
Skipton, Yorkshire	12,000

Slaithwaite, Yorkshire	4,570
Sleaford, Lincolnshire	4,655
Slough, Buckinghamshire	5,427
Smallthorpe, Staffordshire	5,270
Smethwick, Staffordshire	50,000

The Council recently decided to make a trial of Mason's Gasifier.

Scothill Nether, Yorkshire	5,848
Southall, Middlesex	7,560
Southbank, Yorkshire	9,128
South Blyth, Northumberland	3,626
Southborough, Kent	5,416
South Crossland, Yorkshire	3,078
Southgate, Middlesex	13,000
South Hornsey Middlesex	16,892
Southowram, Yorkshire	2,890
Southwick, Durham	10,226
Sowerby, West Riding, Yorkshire	3,850
Sowerby Bridge, Yorkshire	11,500
Soyland, Yorkshire	3,308
Spalding, Lincolnshire	9,014
Spennymoor Durham	16,300
Springhead, Yorkshire	3,630
Staines, Middlesex	5,060
Stainland, Yorkshire	5,002
Standish, Lancashire	5,950
Stanley, Durham	8,290
Stevenage, Hertfordshire	3,309
Stocksbridge, Yorkshire (considering)	5,737
Stone, Staffordshire	5,754
Stourbridge, Worcestershire	9,386
Stourport Worcestershire	5,267
Stowmarket, Suffolk	4,349
Street, Somersetshire	3,517
Stretford, Lancashire	27,000

Have a 2-cell Beaman and Deas Patent Destructor with two 85 horse-power Babcock and Wilcox boilers.

Stroud, Gloucestershire	9,818
Sunbury, Middlesex	4,009

Surbiton, Surrey	13,000
Sutton, Surrey	16,500
Sutton Bridge, Lincolnshire	2,004
Sutton-in-Ashfield, Nottinghamshire	10,563
Swadlincote, Derbyshire	15,000
Swaffham, Norfolk	3,636
Swanage, Dorsetshire	2,668
Swindon, New, Wiltshire	40,230
Under consideration.	
Swinton, Yorkshire	9,297
Swinton and Pendlebury, Lancashire	23,000
Tanfield, Durham	6,497
Tarporley, Cheshire	2,402
Teddington, Middlesex	10,025
Considering.	
Teignmouth, Devonshire	8,171
Considering last year.	
Tetbury, Gloucestershire	2,173
Thame, Oxfordshire	3,335
Tettenhall, Staffordshire	5,145
Thornhill, Yorkshire	10,700
Thornton, Yorkshire	5,680
Thurlstone, Yorkshire	2,735
Tipton, Staffordshire	29,316
Tonbridge, Kent	10,117
Now under consideration.	
Tong, Yorkshire	6,899
Tottenham, Middlesex	85,000

The question of erecting a refuse destructor has been before the Council here some time now, but nothing has yet been definitely decided upon.

At a recent meeting of the Council further complaints regarding non-removal of house refuse were referred to the Sanitary Committee. The Committee reported that they wished to specially direct the Council's attention to the complaints they were constantly receiving respecting the non-removal of house refuse, and also to the great difficulties experienced by the contractor in disposing of the collected refuse. They also urged upon the Council the necessity of proceeding as early as possible with the erection of a destructor.

Tow Law, Durham	4 564
Towyn, Merionethshire	3,294
Trawden, Lancashire	2,354
Tredegar, Monmouthshire	17,341
Tring, Hertfordshire	4,525
Trowbridge, Wiltshire	12,300
Under consideration in connection with the electric lighting scheme.	
Tunstall, Staffordshire	15,730
Turton, Lancashire	14,000
Twickenham, Middlesex	26,026
Tyldesley, Lancashire	10,015
Upholland, Lancashire	4,443
Uckfield, Sussex	2,497
Ulverston, Lancashire	10,115
Urmston, Lancashire	4,042
Uttoxeter, Staffordshire	4,800
Uxbridge, Middlesex	8,206
Ventnor, Isle of Wight	6,090
Considering.	
Walker, Northumberland	15,040
The Council have decided to erect an 8-cell Meldrum Patent Simplex Destructor at once.	
Wallasey, Cheshire	46,000
A number of Fryer Cells are in use here, with also Boulnois & Brodie's Patent Charging Apparatus, and Jones's Fume Cremator was provided with the original installation, which was made about four years ago.	
Wallsend, Northumberland	11,620
Walmer, Kent	4,565
Walsoken, Norfolk	2,771
Waltham Cross, Essex	6,066
Walthamstow, Essex	75,000
Under consideration.	
Walton-le-dale, Lancashire	10,556
Walton-on-Thames, Surrey	7,988
Wanstead, Essex	7,042
Wantage, Berkshire	3,669

Warblington, Hampshire	2,849
Wardle, Lancashire	3,962
Ware, Hertfordshire	5,121
Warley, Yorkshire	2,912
Warminster, Wiltshire	5,562
Waterloo, Lancashire	23,058
Under consideration; a joint scheme with Great Crosby suggested.	
Watford, Hertfordshire	16,819
Considering.	
Wath-upon-Dearne	7,048
Wealdstone, Middlesex	4,000
Wednesfield, Staffordshire	4,949
Weetslade, Northumberland	5,000
Wellingborough, Northamptonshire	15,068
Messrs. W. F. Mason, Limited, Manchester, have order in hand for their patent refuse gasifier.	
Wellington, Shropshire	5,831
Wellington, Somersetshire	6,808
Wells, Norfolk	2,536
Wembley, Middlesex	4,300
West Bridgford, Nottinghamshire	2,503
The question has been before the Council.	
Westbury, Gloucestershire	2,005
Westhoughton, Lancashire	12,500
Weston-super-Mare, Somersetshire	15,864
Weybridge, Surrey	3,944
Wickham, Durham	9,174
Whitby, Yorkshire	13,075
Considering.	
Whitchurch, Shropshire	4,794
Whitefield, Lancashire	5,776
Whitley, Northumberland	3,008
Whitstable, Kent	6,200
Whittington, Derbyshire	8,798
Tipped in March, 1899. Application was made to the Local Government Board for £800 loan for cost of tipping.	
Whittlesey, Cambridgeshire	
Whitwood, Yorkshire	

Whitworth, Lancashire	9,766
Wigston, Leicestershire	8,709
Willenhall, Staffordshire	18,669
Under consideration.	
Willesden, Middlesex	88,322
Now under consideration. The refuse is at present given to a brickmaker.	
Willington, Durham	7,804
Willington Quay, Northumberland	8,302
Wilmslow, Cheshire	6,344
Wilsden, Yorkshire	2,764
Wimbledon, Surrey	39,000
Have a Beaman and Deas Patent Destructor (two cells), and Babcock and Wilcox Boilers supplying steam to electric lighting station.	
Wimborne, Dorsetshire	3,500
Winsford, Cheshire	10,440
Wirksworth, Derbyshire	3,725
Witham, Essex	3,444
Withington, Lancashire	33,410
Here are six cells of the Surveyor's own design, erected by Messrs. W. F. Mason, Limited. (Figs. 29 and 30.) Seven to eight tons per cell per day are consumed, at a cost of 8d. per ton for labour.	
Withnell, Lancashire	2,779
Witney, Oxfordshire	3,110
Woking, Surrey	16,000
Wombwell, Yorkshire	13,500
Woodbridge, Suffolk	14,000
Wood Green, Middlesex	30,000
Plans and tenders are now before the Council.	
Worksop, Nottinghamshire	12,734
Worsborough, Yorkshire	9,905
Worsley, Lancashire	12,850
Wrotham, Kent	3,437
Yeadon, Yorkshire	7,396
Ynyscynhavarn, Carnarvonshire	5,224
Ystradyfodwg, Glamorganshire	88,350

In those towns without remark no-move has yet been made towards sanitary disposal.

TESTS MADE ON THE BEAMAN AND DEAS DESTRUCTOR AT THE ELECTRICITY WORKS, WIMBLEDON.

Date of test ...	June 26th, 1900	June 27th, 1900
Duration of test	7 hours	8¼ hours
Kind of fuel burned	Unscreened ashpit refuse	Unscreened ashpit refuse
	T. c. qrs. lbs.	T. c. qrs. lbs.
Total weight of fuel burned	12 12 1 19 = 28,271 lbs.	14 3 3 14 = 31,794 lbs.
Weight burned per hour	1 16 0 6 = 4,038 lbs.	1 14 1 17 = 3,853 lbs.
Weight burned per square foot of grate area per hour	80 lbs.	77 lbs.
Rate of combustion per 24 hours	43·22 tons.	41·28 tons
Total weight of clinker and ash	2 6 3 14 = 5,250 lbs.	4 15 2 7 = 10,703 lbs.
Percentage of clinker and ash ...	See note. 18½ per cent.	33·6 per cent.
Total water evaporated	24,533 lbs.	27,287 lbs.
Water evaporated per hour	3,504 lbs.	3,307 lbs.
Water evaporated per lbs. of refuse actual	·867 lbs.	·858 lbs.
Water evaporated per lbs. of refuse	See note	1·006 lbs.
Temperature of feed water	Not taken	88° F.
Average steam pressure	Not taken	120 lbs.
Average air pressure under grates by water gauge	2½ in.	2½ in.
Average chimney pull, recorded by gauge on main flue	⅜ "	⅜ "

Remarks.—*June 26th.*—On this day's test the feed water passed through the meter heated, and as there was no thermometer or pocket on same could not get the temperature.

Two loads of clinker were taken away by strange carter without being weighed. This accounts for the low percentage recorded.

The refuse on all four days of test was of very poor quality, containing a very large percentage of garden garbage.

TESTS MADE ON THE BEAMAN AND DEAS DESTRUCTOR AT THE ELECTRICITY WORKS, WIMBLEDON.—*Continued.*

Date of test	June 28th, 1900	June 29th, 1900
Duration of test	7 hours	6¾ hours
Kind of fuel burned	Unscreened ashpit refuse 2 parts Pressed Sludge 1 part	Unscreened ashpit refuse 2 parts Pressed sludge 1 part
Total weight of fuel burned	T. c. qrs. lbs. Refuse 8 13 1 0 Sludge 4 6 0 0 = 29,036 lbs.	T. c. qrs. lbs. Refuse 9 0 2 21 Sludge 4 10 0 0 = 30,317 lbs.
Weight burned per hour	T. c. qrs. lbs. 1 17 0 4 = 4,148 lbs.	T. c. qrs. lbs. 2 0 0 11 = 4,491 lbs.
Weight burned per square foot of grate area per hour	82½ lbs.	89·8 lbs.
Rate of combustion per 24 hours	44·4 tons	48·1 tons
Total weight of clinker and ash	3 11 3 14 = 8,050 lbs.	3 17 3 21 = 8,729 lbs.
entage of clinker and ash	27·7 per cent.	28·79 per cent.
ater evaporated	15,749 lbs.	14,871 lbs.
vaporated per hour	2,249 lbs.	2,203 lbs.
vaporated per lbs. of refuse actual	·542 lbs.	·490 lbs.
evaporated per lbs. of refuse (212°F.)	·639 lbs.	·563 lbs.
perature of feed water	77° F.	100° F.
Average steam pressure	116·5 lbs.	78·8 lbs.
Average air pressure under grates by water gauge	2½ in.	2½ in.
Average chimney pull, recorded by gauge on main flue	¾ "	¾ "

CHAPTER XV.

REFUSE DISPOSAL IN SCOTLAND.

COMPARATIVELY speaking, very little headway has been made here in the sanitary disposal of refuse, which is somewhat surprising, seeing that most of the towns, at any rate, in the West of Scotland are populous and prosperous, and that, generally speaking, local authorities have shown a very commendable enterprise in effecting improvements for the good of the community.

Here I specially refer to towns such as Coatbridge, Hamilton, Kilmarnock, and others of the same type—all veritable hives of industry, and, of a necessity, thickly populated.

We will first take GLASGOW. Population, 724,349.

In this city the disposal of the refuse is in the hands of the Cleansing Department, who dispose of the refuse regularly and very methodically, if not on quite up-to-date lines.

The Department is directly under the control of the Municipality, and there can be no doubt that the methods employed for the disposal of the various kinds of refuse are very economical.

The Cleansing Department own nearly 1,000 railway wagons, and the useful products from the refuse find a ready sale among farmers in many counties. They own two estates which cover an area of 717 acres; also renting two farms, some miles out of the city, where unsaleable refuse is tipped.

As Glasgow has been, and is yet, a wonderful example to the world as to the success of municipal enterprise, I think a brief description of their methods of refuse destruction will be of interest.

There are four Destructor Works in the city, viz., St. Rollox, Kelvinhaugh, Dalmarnock and Haghill. The St. Rollox Despatch Works were opened in 1881, being not only the first of the kind in that city, but also in Scotland, at which an attempt was made by a screening and mixing process to produce from the city refuse a good fertilizer, and, by a process of cremation, to destroy all useless and objectionable refuse.

At the St. Rollox Works are four natural draught cells, each with a grate area of 58 square feet; the total average quantity consumed per day is 28 tons. During the year ending May 31, 1899, the total quantity of material dealt with at this Works was 65,593 tons; of this quantity, 8,368 tons was stable manure, all of which was sold. Of the remaining 59,225 tons, 17,689 tons were sold to farmers for manure, a large proportion going as far north as Perth, Forfar and Kincardine.

1,929 tons of clinker were sold, the balance of unsaleable material sent to the tips being 30,114 tons. At this Works the steam generated is used for driving various machinery in the Works. All the vehicles, trucks, etc., belonging to the Department are repaired at this branch.

At Kelvinhaugh there are four natural draught cells similar to those at the St. Rollox Works; the quantity of refuse dealt with per day is also the same.

Dalmarnock Works. Here are also four cells precisely similar to those already described; but just now the authorities are considering the adoption of an additional eight modern high temperature cells; when these are erected it is intended to use the heat available for steam raising.

The Haghill Works were the last to be started, only being opened in December, 1897. Here are installed five cells of the Horsfall type, each of which has a grate area of 58 square feet; a boiler was also put down to utilise the waste heat from the cells, the steam being used for driving machinery for treating the refuse, for lighting the Works by electricity, and for providing steam for the forced draught jets.

The Corporation have recently contracted with Messrs. Meldrum Brothers, Limited, to erect an 8-cell Destructor at Dalmarnock.

PARTICK.—After visiting a number of installations in various parts of the country, the Council recently invited tenders for a destructor, through their Consulting Engineers, Messrs. Kincaid, Waller and Manville.

GOVAN.—Here is a 6-cell Destructor erected by Messrs. Goddard, Massey and Warner in 1892; two more cells of the same type were added in 1894, and two additional cells are now in hand. Each cell deals with 4·8 tons per 24 hours; the cost of burning is given as 1s. 6·6d. per ton.

Edinburgh (295,628).—In 1893, Messrs. Manlove, Alliott and Co., Limited, erected a 10-cell Fryer Destructor on a site known as Powderhall. To make a long story short, the cells failed to burn the quantity they were said to be capable of destroying, and, what was more unfortunate in some respects, litigation was caused by reason of escaping fumes and dust, although fume cremators were provided.

After serious trouble and expense, it was at length arranged with the Horsfall Destructor Co., Limited, to reconstruct the cells and take away the cremators, under a binding guarantee that, firstly, "No imperfectly consumed noxious gases or dust should escape from the chimney"; secondly, "No noxious fumes or dust should escape from the clinkering floor"; thirdly, "No bad smells should be given off from the feeding chamber from whatsoever cause."

Further, "That not less than eight tons of refuse be consumed per cell per day." These requirements were fulfilled.

Dundee (164,575).—Here the refuse is partly sold and partly tipped; the authorities say that these methods are far better than facing the expense of erecting a destructor.

Aberdeen (140,381).—The refuse is also partly sold and partly tipped here. The advisability of erecting a destructor was under the consideration of the Council at the same time as their electric lighting scheme; the latter was carried to a successful issue; the former, apparently, is in abeyance still. Out of some 80,000 loads of refuse collected annually, only 25,000 loads are fit to be sold, the remainder being tipped.

The question has recently been revived and it is now decided to erect a destructor to deal with about 15 tons per day as an experiment.

Ayr.—The refuse is tipped.

Greenock (63,423).—The refuse is tipped.

Lanark (4,579).—The refuse is tipped.

Leith (76,277).—The refuse is tipped.

Oban (4,902).—The refuse is used for reclaiming an inland lake.

Paisley (7,553).—An eight-cell Horsfall Destructor is now in hand.

Port Glasgow (14,624).—The refuse is tipped.

Peterhead (12,195).—The refuse is tipped.

Dunbar (3,545).—Now considering the adoption of a destructor.

Dunfermline (22,365).—Now considering the adoption of a destructor.

Uddingston (6,000).—A 2-cell Horsfall Destructor is now in hand.

Broughty Ferry (9,256).—A deputation visited the Shoreditch installation in May, 1898, but Mr. Newton Russell advised them not to adopt a destructor while they could draw any revenue at all from their refuse for manure.

Gourock (9,000).—With commendable enterprise, some of the Council here, at this beautifully-situated watering-place on the Firth of Clyde, have persistently urged the adoption of a destructor. A site has been chosen, and it is very probable indeed that Gourock will have the credit of being the first Scottish watering-place to dispose of its refuse in the only sanitary manner.

Falkirk (19,769).—The advisability of providing a destructor in connection with electric lighting has been under consideration, but up to the present nothing has been done.

South Govan.—The Municipality decided to make this a separate scavenging district, and in doing so to at once consider the adoption of destructors.

Rothesay (9,108).—A deputation visited a number of installations in England two years ago. In the course of their travel they visited Oxford, where refuse is buried in pasture land. They decided to do likewise : a very extraordinary decision for the authorities of the Queen of Scottish seaside resorts.

Ardrossan (4,760).—For two years past the adoption of a destructor has been under consideration here. A deputation visited Edinburgh and other places early in 1899, but nothing has yet been done.

Motherwell (2,800).—A deputation visited Leeds, Bradford, Edinburgh, Manchester, and other places early in 1899 to inspect and report on destructors.

Communities with Populations of over 2,000 each.

Aberlour, Banffshire	2,200
Airdrie, Lanarkshire	19,138
Alexandria, Dumbartonshire	7,796

Alford, Aberdeenshire	2,000
Alloa, Clackmannanshire	12,643
Alva, Stirlingshire	6,000
Alyth, Perthshire	2,322
Annan, Dumfries-shire	4,860
Arbroath, Forfarshire	24,960
Ayr, Ayrshire	25,213
Banff, Banffshire	3,876
Bannockburn, Stirlingshire	2,459
Barrhead, Renfrewshire	8,215
Bathgate, Linlithgowshire	5,851
Beith, Ayrshire	4,795
Blairgowrie, Perthshire	3,714
Boness, Linlithgowshire	5,866
Bonhill, Dumbartonshire	3,843
Buckie, Banffshire	5,843
Burntisland, Fifeshire	4,692
Brechin, Forfarshire	8,955
Broxburn, Linlithgowshire	5,898
Buckhaven, Fifeshire	4,006
Cambuslang, Lanarkshire	8,323
Campbelltown, Argyleshire	8,235
Carnoustie, Forfarshire	4,184
Castle Douglas, Kirkcudbrightshire	2,870
Clydebank, Lanarkshire Under consideration.	10,589
Coupar, Forfarshire	2,106
Cowdenbeath, Fifeshire	4,249
Crieff, Perthshire	4,901
Cullen, Banffshire	2,100
Cumnock (Old), Ayrshire	3,105
Cupar, Fifeshire	4,729
Dalry, Ayrshire	8,500
Dalbeattie, Kirkcudbrightshire	4,000
Dalkeith, Edinburghshire	7,035
Dingwall, Ross-shire	2,300
Dumbarton, Dumbartonshire	17,626
Dumfries, Dumfries-shire	18,051
Dunblane, Perthshire	2,106
Dunoon	7,00

Duns, Berwickshire	2,198
Dysart, Fifeshire	12,849
Elgin, Elginshire	7,799
Eyemouth, Berwickshire	2,576
Forfar, Forfarshire	12,844
Forres, Elginshire	3,971
Fraserburgh, Aberdeenshire	7,466
Fyvie, Aberdeenshire	4,049
Galashiels, Selkirkshire	17,249
Galston, Ayrshire	4,292
Girvan, Ayrshire	4,081
Grangemouth, Stirlingshire	5,833
Huntly, Aberdeenshire	3,760
Haddington, Haddingtonshire	3,770
Hamilton, Lanarkshire	24,863
Hawick, Roxburghshire	19,204
Innerleithen, Peebles-shire	2,501
Inverurie, Aberdeenshire	3,105
Inverness, Inverness-shire	20,855
Irvine, Ayrshire	9,037
Jedburgh, Roxburghshire	3,397
Johnstone, Renfrewshire	9,668
Keith, Banffshire	4,622
Kelso, Roxburghshire	4,184
Kilbarchan, Renfrewshire	2,747
Kilbirnie, Ayrshire	3,405
Kilmarnock, Ayrshire	28,438
Kincardine, Perthshire	2,007
Kinghorn, Fifeshire	2,036
Kirkcaldy, Fifeshire	27,151
Kirkintilloch, Dumbartonshire	10,312
Kirkwall, Orkney	3,895
Kirriemuir, Forfarshire	4,179
Kilsyth, Stirlingshire	6,073
Langholm, Dumfries-shire	3,642
Largo, Ayrshire	3,187
Lerwick, Shetland	3,782
Leslie, Fifeshire	3,421
Lesmahagow, Lanarkshire	9,000
Leven, Fifeshire	4,577

Linlithgow, Linlithgowshire	4,154
Loanhead, Edinburghshire	3,244
Lochee, Forfarshire	13,867
Lochgelly, Fifeshire	4,133
Lockerbie, Dumfries-shire	2,491
Lossiemouth, Elginshire	4,000
Macduff, Banffshire	3,707
Maybole, Ayrshire	5,470
Moffatt, Dumfries-shire	2,976
Montrose, Forfarshire	13,048
Musselburgh, Edinburghshire	8,855
Nairn, Nairnshire	4,014
Newport, Fifeshire	2,947
Newton Stewart, Wigtonshire	2,758
Newquay, Haddingtonshire	2,376
Peebles, Peebles-shire	4,704
Penicuik, Edinburghshire	3,606

PERTH.—After carefully considering the matter it has practically been decided to erect a destructor in the "Fair City." As will be seen from the following statement, the present method of handling the refuse is costly :—

	£	s.	d.
Cartage to Friarton Depôt	1,300	0	0
Two men cleaning	120	0	0
Loading 10,000 tons on trucks at 3d. per ton	125	0	0
Removing 3,000 tons unsaleable	75	0	0
Total	1,620	0	0
Received from sale of manure, average	700	0	0
Annual loss to city	920	0	0

The cost of treating the 10,000 tons thus works out at 2s. 5½d. per ton, 10,000 tons being sold, after cleaning, for 1s. 6d. per ton.

Against these figures were set the following approximate estimate of the annual cost with a destructor :—

	£	s.	d.
Cost of destructor	4,000	0	0
Annual payment £5½ per cent. ...	220	0	0
Carting 11,000 tons of refuse to destructor at 1s. 6d. per ton	825	0	0
Carting 2,000 tons of refuse to railway at 1s.	100	0	0
Two extra firemen at 25s. each weekly ...	130	0	0
Depreciation	100	0	0
Cost of site and insurance	50	0	0
Total	1,425	0	0
From which deduct the following :—			
2,000 tons of manure, slaughter-house, etc., 2s. 6d. per ton	250	0	0
Value of steam to electric light works ...	700	0	0
Value of clinker	100	0	0
Total ...	1,050	0	0

Pollokshaws, Lanarkshire	10,445
Port Glasgow, Renfrewshire	14,624
Portsoy, Banffshire	2,091
Prestonpans, Haddingtonshire	2,294
Renfrew, Renfrewshire	6,777
Renton, Dumbartonshire	5,458
Rothes, Morayshire	2,299
Rutherglen, Lanarkshire	13,083
Selkirk, Selkirkshire	6,397
Shotts, Lanarkshire	11,957
St. Andrews, Fifeshire	6,853
Stevenston, Ayrshire	3,556
Stewarton, Ayrshire	2,687
Stirling, Stirlingshire	16,895
Stonehaven, Kincardineshire	4,497
Stranraer, Wigtonshire	6,193
Strathaven, Lanarkshire	3,478
Tayport, Fifeshire	2,829

Thurso, Caithness-shire	3,930
Tillicoultry, Clackmannanshire	3,939
Troon, Ayrshire	4,108
Turriff, Aberdeenshire	2,340
Wick, Caithness-shire	8,463
Wishaw, Lanarkshire	15,525

SUMMARY.

Out of 148 towns, cities, etc., in Scotland, each with populations exceeding 2,000, three only actually have destructors in operation; three others have definitely decided to adopt destructors; nine are considering the advisability of providing destructors.

CHAPTER XVI.

REFUSE DISPOSAL IN IRELAND.

LITTLE progress can be reported in the "disthressful counthry." Apart from Belfast and Dublin, nothing whatever has been done in the way of destruction by fire, although there are a number of populous and thriving towns in Ulster, at any rate, which claim to be progressive.

DUBLIN (population, 245,000).—The first destructor to be erected was a 4-cell plant of the Fryer type by Messrs. Manlove, Alliott and Co.; about 6 tons per cell per day are destroyed at a cost per ton of 9·9d. for wages.

Messrs. Goddard, Massey and Warner have since erected three of their Warner "Perfectus" cells.

In the chapter entitled "Refuse Tipping" reference is made to a recent prosecution of the Corporation for causing a nuisance by tipping the city's waste, and it would really appear that the sanitary disposal of refuse is not taken to heart at all seriously by the authorities; in short, it is cheaper to tip either on land or at sea. Needless to add, the present cells are quite inadequate.

The Committee of the Local Government Board for Ireland, which was appointed to inquire into and report upon the public health of Dublin, issued a report in May this year in which a number of recommendations were made with a view to sanitary reform. As regards the disposal of refuse, they suggest that "an additional destructor be provided in Marrowbone Lane, and that the number of cells at the Stanley Street Destructor be increased." Further, "that a suitable berth should be provided for the barge *Eblana*." This barge is used for taking a large quantity of the refuse out to sea.

PEMBROKE (township, Co. Dublin).—Here the first modern high temperature destructor in Ireland has recently been erected by the Horsfall Destructor Co., Ltd. It consists of two cells identical with those installed at Norwich and a Babcock and Wilcox Boiler to work at 140 lbs. pressure, with 735 square feet of heating sur [illegible] f 80 horse-power.

BELFAST (population, 255,950).—Here Messrs. Goddard, Massey and Warner are erecting a 12-cell destructor.

Here is a list of the boroughs showing the population in each case. All are alike in the disposal of refuse. In every case it is either tipped or disposed of in some equally primitive manner :—

Clonmel ...	10,500
Cork ...	97,281
Drogheda	13,000
Kilkenny	11,048
Limerick	37,155
Londonderry	33,200
Sligo ...	10,274
Waterford	27,713
Wexford	12,000

There are also some 63 urban sanitary districts, all apparently being in the same position as the boroughs named above, but of course many of the urban sanitary districts are only comparatively thinly populated.

Communities with populations of 2,000 and upwards, not one of which is provided with a destructor :—

Ardee, Louth	2,067
Armagh, Armagh ...	7,438
Arklow, Wicklow ...	5,294
Athlone, West Meath	6,742
Athy, Kildare ...	4,866
Balbriggan, Dublin	2,273
Ballina, Mayo ...	4,846
Ballinasloe, Galway	4,642
Ballymena, Antrim	8,655
Ballymoney, Antrim	2,975
Ballyshannon, Donegal	2,471
Banbridge, Down	4,901
Bandon, Cork ...	3,488
Bantry, Cork ...	3,900
Blackrock, Dublin	8,380
Boyle, Roscommon	2,464
Bray, Wicklow ...	6,888
Cahir, Tipperary ...	2,046
Cahircineen, Kerry	2,000

Carlow, Carlow	6,919
Carrickfergus, Antrim	8,923
Carrick-on-Suir, Tipperary	5,808
Cashel, Tipperary	3,216
Castlebar, Mayo	2,557
Cavan, Cavan	2,963
Clonakilty, Cork	3,221
Clones, Monaghan	2,300
Coleraine, Londonderry	6,845
Comber, Down	3,500
Cookstown, Tyrone	3,841
Dalkey, Dublin	3,197
Downpatrick, Down	3,132
Dundalk, Louth	12,499
Dungannon, Tyrone	3,812
Dungarvan, Waterford	5,263
Ennis, Clare	5,460
Enniscorthy, Wexford	5,648
Enniskillen, Fermanagh	5,570
Fermoy, Cork	6,469
Galway, Galway	16,959
Gorey, Wexford	2,266
Kells, Meath	2,427
Killarney, Kerry	5,510
Killyleigh, Down	2,000
Kingstown, Dublin	17,352
Kilrush, Clare	4,095
Larne, Antrim	4,217
Letterkenny, Donegal	2,500
Limavady, Londonderry	2,799
Lisburn, Antrim	12,290
Listowel, Kerry	3,566
Longford, Longford	3,827
Loughrea, Galway	2,815
Lurgan, Armagh	11,570
Macroom, Cork	2,933
Mallow, Cork	4,366
Maryborough, Queen's County	2,109
Monaghan, Monaghan	2,938
Mountmellick, Queen's County	2,623

Mullingar, Westmeath	5,323
Naas, Kildare	3,735
Navan, Meath	3,963
Nonagh, Tipperary	4,722
Newbridge, Kildare	3,391
Newcastle West, Limerick	4,000
New Ross, Wexford	5,847
Newtownards, Down	9,197
Newry, Down	13,691
Omagh, Tyrone	4,039
Parsonstown, King's County	4,313
Portadown, Armagh	8,430
Portarlington, King's County	2,000
Queenstown, Cork	9,755
Rathkeale, Limerick	2,400
Roscommon, Roscommon	2,000
Roscrea, Tipperary	2,568
Skibbereen, Cork	3,262
Strabane, Tyrone	5,023
Templemore, Tipperary	2,800
Thurles, Tipperary	4,511
Tipperary, Tipperary	6,391
Tralee, Kerry	9,308
Tramore, Waterford	2,000
Tuam, Galway	3,012
Tullamore, King's County	4,522
Westport, Mayo	4,070
Wicklow, Wicklow	3,273
Youghal, Cork	4,317

SUMMARY.

Out of 100 towns, cities, etc., in Ireland, each with populations exceeding 2,000, two only actually have destructors in operation. One only (Belfast) has a destructor in course of erection.

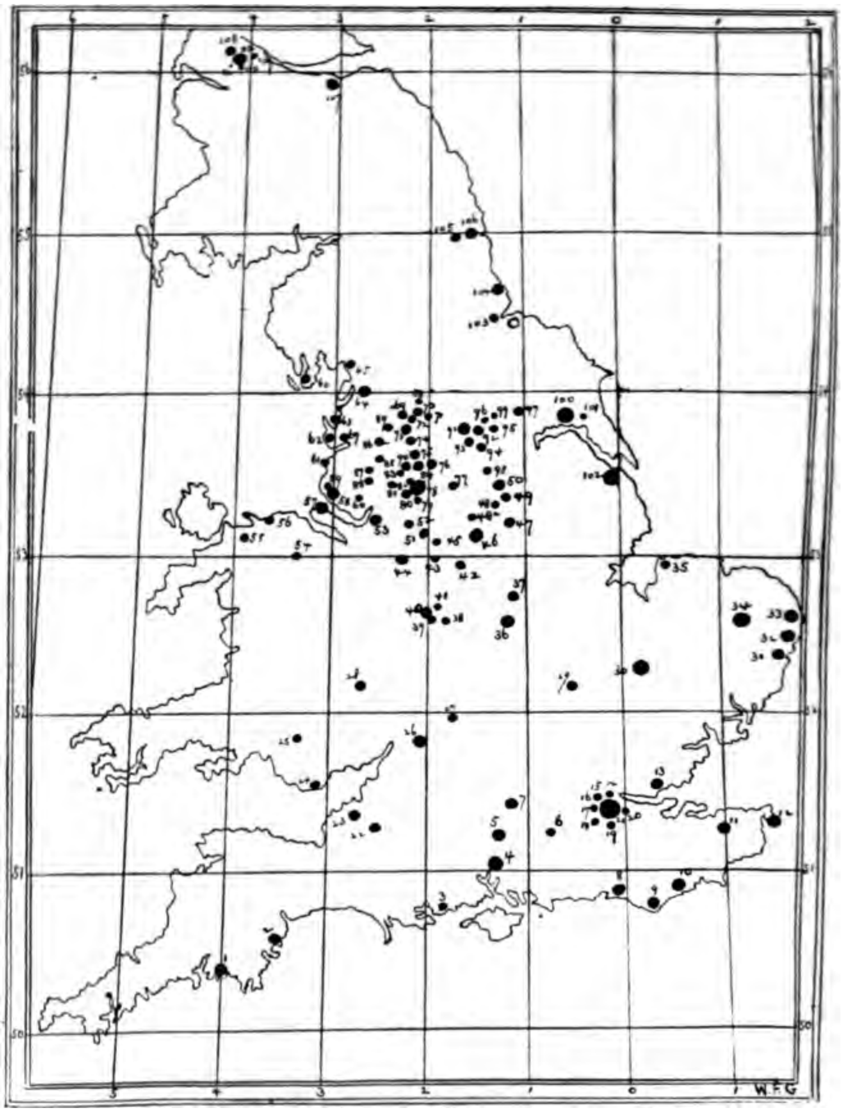


FIG. 31.—CHART SHOWING TWENTY-FIVE YEARS' PROGRESS IN ADOPTION OF REFUSE DESTRUCTORS IN GREAT BRITAIN.

INDEX TO CHART SHOWING TWENTY-FIVE YEARS' PROGRESS IN REFUSE DESTRUCTION.

1. Plymouth.
2. Torquay.
3. Bournemouth.
4. Southampton.
5. Winchester.
6. Aldershot.
7. Basingstoke.
8. Brighton.
9. Eastbourne.
10. Hastings.
11. Canterbury.
12. Ramsgate.
13. Grays.
14. Hornsey.
15. Ealing.
16. Brentford.
17. Wimbledon.
18. Beckenham.
19. Ealing.
20. Leyton.
21. London—
    - Battersea.
    - Bermondsey.
    - City.
    - Clerkenwell.
    - Fulham.
    - Hackney.
    - Hampstead.
    - Lambeth.
    - Lewisham.
    - St. Luke's.
    - St. Pancras.
    - Poplar.
    - Rotherhithe.
    - Shoreditch.
    - Strand.
    - Streatham.
    - Whitechapel.
    - Woolwich.
22. Bath.
23. Bristol.
24. Barry.
25. Merthyr Tydvil.
26. Gloucester.
27. Cheltenham.
28. Hereford.
29. Wellingborough.
30. Cambridge.
31. Southwold.
32. Lowestoft.
33. Great Yarmouth.
34. Norwich.
35. Hunstanton.
36. Leicester.
37. Loughborough.
38. Smethwick.
39. Aston Manor.
40. Birmingham.
41. Handsworth.
42. Burton-on-Trent.
43. Longton.
44. Stafford.
45. Burslem.
46. Derby.
47. Nottingham.
48. Chesterfield.

48A. Buxton.

49. Rotherham.
50. Sheffield.
51. Hanley.
52. Ashton-under-Lyne.
53. Warrington.
54. Wrexham.
55. Bangor.
56. Llandudno.
57. Birkenhead.
58. Bootle.
59. Liverpool.
60. St. Helens.
61. Southport.
62. Blackpool.
63. Fleetwood.
64. Lancaster.
65. Morecambe.
66. Barrow-in-Furness.
67. Preston.
68. Nelson.
69. Accrington.
70. Burnley.
71. Colne.
72. Padiham.
73. Blackburn.
74. Darwen.
75. Rochdale.
76. Oldham.
77. Dewsbury.
78. Manchester.
79. Withington.
80. Stretford.
81. Heywood.
82. Salford.
83. Bolton.
84. Bury.
85. Hyde.
86. Moss Side.
87. Rawtenstall.
88. Royton.
89. Radcliffe.
90. Farnworth.
91. Bradford.
92. Shipley.
93. Mexborough.
94. Wakefield.
95. Leeds.
96. Batley.
97. York.
98. Huddersfield.
99. Heckmondwike.
100. Hull.
101. Beverley.
102. Great Grimsby.
103. Stockton-on-Tees.
104. Hartlepool.
105. Walker-on-Tyne.
106. Newcastle-on-Tyne.

SCOTLAND.

107. Edinburgh.
108. Paisley.
109. Fallside.
110. Partick.
111. Govan.
112. Glasgow.

Not shown on map—

IRELAND.—Dublin, Pembroke (Dublin), Belfast, also St. Heliers, Channel Islands.

Introduction to Chapter XVII. by Colonel W. F. Morse, Consulting Sanitary Engineer, New York City.

The production of waste is a penalty of life, and the question of its sanitary disposal as a protection for health is one that appeals strongly to every good citizen, as something that concerns him personally. Slowly, but surely, there is growing upon the public mind the impression that there is a better means of getting rid of worthless and dangerous matter than by emptying it upon the nearest unoccupied ground, or into adjacent water, regardless of future consequences, and with this increasing interest comes the inquiries concerning methods, apparatus, machines, or devices for dealing with waste, which shall be at once sanitary, efficient, and economical, a problem that has not as yet been completely solved.

About 75 American cities and towns have, in ten years, experimented with a variety of methods for improvement in waste disposal, and at this time nearly 100 other places are seeking information and awaiting the advent of something that shall be still more satisfactory. Of the methods employed, two only have been found to have value, and all experiments have been conducted by one or the other of these.

The System of Reduction deals only with refuse food products and kitchen garbage—about 12 per cent. of the total city waste—and manufactures these, by a process of steam or naphtha treatment, into commercial products—grease and tankage, the latter being used as a basis for fertilizers. Complicated and costly plants have been erected. The business has been carried on for 12 years under conditions eminently favourable; but the results are as yet not altogether satisfactory in either a commercial or a sanitary way, and the general tendency seems to be the abandonment of the utilisation process for the small proportion of garbage, in favour of the general disposal of all municipal waste by other means.

The Method of Cremation takes all things worthless, offensive, or dangerous, and transforms them into ashes. Only such articles and substances as by their nature are inoffensive, and possess some value without the need of further treatment, are saved and turned to useful purposes; everything else is reduced by the agency of fire to the lowest form of innocuous ash.

The sanitary questions involved in this subject of waste disposal must control all other considerations. To substitute an insanitary method is merely to perpetuate the trouble in another and possibly a more offensive form. Hence, no system, apparatus, or process of treatment that does not give immunity from nuisance when in operation, should be considered or adopted for municipal work.

Tried by this rule, the results of reduction systems, when located in the neighbourhood of thickly settled communities, have been distinctly unfavourable, because of the odours from large quantities of accumulated waste, and the escape of noxious fumes in the manufacturing processes. When the works are removed to a distance from the collection field, the cost of transportation becomes an important item, often increasing the expense to an amount considerably greater than the cost of disposal by cremation.

On the other hand, the fact that more than 200 cities and towns in several different countries are using destructors or cremating furnaces, often placed amid populous centres, must be accepted as satisfactory evidence of the possibility of disposal of all classes, kinds, and quantities of municipal waste by fire, without objectionable results on the ground of sanitation.

In the American practice, the disposal by fire has been applied to the garbage, or putrescible matter, only. This is separately collected, brought to a central point, and consumed, by using fuel, which is always a costly item in the city expenses. But little attention has been paid to the great bulk of combustible refuse which can be used as fuel ; nor has there been, except in one instance, any attempt to utilise the heat produced for useful purposes.

Thus, when the destruction of one-eighth of the whole city collection by fire becomes expensive, and the remaining seven-eighths are left to be dealt with in other ways, naturally the city authorities are somewhat slow to adopt reforms that do not promise a thorough and permanent value, and are desirous of some means that will care for the whole waste collection at a cost that is not prohibitory, and in a manner that shall be sanitary.

And at this point stands the present condition of affairs in this country.

The American type of cremator for municipal use has practically reached its limit in the disposal of small quantities of putrescible waste, and when used for mixed miscellaneous matters, operates slowly and imperfectly, as it depends upon natural chimney draught for its power, making poor combustion at low temperatures, with resulting nuisance.

The small special destructors employed for the cremation on the premises of the mixed waste of institutions, hospitals, factories, hotels, and houses, are found to be efficient and sanitary within their limited capacity, but count for little in the general disposal work.

With the exception of two places, none of the American cities have instituted means or works for the recovery of the marketable portions of the light refuse, which forms one-sixth of the whole city waste product, and when properly collected and sorted is a very considerable item for the credit side of the expense account.

There is an enormous waste of useful power lost in the present methods of cremation. Burning coal to evaporate the 1,400 lbs. of water in each ton of separated garbage, and then throwing away the heat generated by the combustion of both fuel and waste, is a wilful expenditure of force not justified by the situation.

But there must be a better way to institute and conduct this disposal work, and a remedy for existing deficiencies. The disposal work should be placed under the control of the Engineering Department, and the City Engineer, aided by expert advice if necessary, should furnish accurate information of the amount and character of waste, and after examination of the various methods and appliances offered, should report upon that which the experience of other places and the best attainable knowledge would suggest as the one most suitable. To obtain the best results, every detail of this work should be directed by trained men, precisely as other city departments are carried on.

There must come at once a change in the methods of cremation to be applied in the larger cities, by the introduction of larger, more efficient, and more durable furnace constructions, that shall be able to consume everything at the smallest cost for fuel and labour; not compel a particular separation of the wastes, and which, while entirely sanitary in operation, shall return something to defray the expenses in the way of power from the heat generated, from the articles and substances sorted from the light refuse, and sold, and employ the ash residuum for various municipal purposes.

That some radical change is demanded by the present conditions existing in America must be evident to anyone who has given attention to this subject, and a great advance and improvement in furnace construction used in other countries, is obvious to all who will examine the work done abroad in this direction.

The beginning of Towns' Refuse Disposal in England antedates the American work in this line by nearly 15 years. Their history shows a progressive development from the first crude forms of destructive furnaces, down through successive experiments at a great number of places, to the present time, when the Refuse Destructor is as much a part of the municipal service as the machinery of the sewerage, or fire, or water departments. The work has assumed an engineering importance fully warranted by the magnitude of the financial questions involved, the employment of the great forces developed by the destructors, and the utilisation of the residuums as substitutes for more expensive material.

Compelled by a stern necessity for the sanitary treatment of the refuse from a thickly-settled population, the English cities have provided for a liberal expenditure of money, and for years have sought for the best agencies and appliances for waste disposal.

Their experience and their conclusions are applicable to other cities where the conditions of life are nearly the same, and the waste of a like character. Why may not American cities profit by this example and in their turn transform into useful force the great mass of worthless matter they are burdened with, and for which they pay large sums to be rid of?

Given the same conditions, with similar methods and the same or equally efficient apparatus, corresponding results can be had, and our towns be lighted, the street railroads operated, and other municipal work done by the agency of what all now discard as worthless and useless.

In this book—"The Economic Disposal of Town's Refuse"—the author has recorded the experience gained by the cities of

Great Britain in 25 years of work in this special department of public affairs. This has been a work involving considerable care and study, and requiring special and technical training. The result is a contribution to sanitary literature of the highest value and usefulness, a clear, comprehensive account of what has been accomplished and the agencies by which real progress has been made. It comes at an opportune time, when, because of plague and epidemic disease among nearly all nations, the minds of city authorities are turned toward improvement of the sanitary conditions, and both authorities and citizens are interested in the preventive means for quickly disposing of dangerous filth, that are here described and illustrated.

W. F. MORSE.

New York, December, 1900.

CHAPTER XVII.

REFUSE DISPOSAL IN AMERICA.

ALTHOUGH American engineers have shown us much that will have an enduring effect in our country, both in applications of mechanical and electrical engineering, yet we cannot allow that our ingenious friends have taught us anything serious in sanitary science. While American practice in sanitary and final refuse disposal can in no way be compared with our practice, yet there is a decided demand existing in that country now for a higher and more efficient sanitary standard. As regards New York City, the late Colonel George E. Waring may be said to have been responsible for the present satisfactory condition of the city ; not only did he substitute method for chaos, as regards the handling of domestic waste, but he brought the street-cleaning arrangements up to an excellent standard. It is doubtful indeed whether there is a city in this country, or in Europe, which can equal New York for efficient street cleaning —certainly none can surpass it. Mr. Macdonough Craven, C.E., of New York City, in reading a paper entitled "Waste Disposal and its Advances" before the American Public Health Association at Minneapolis, Minnesota, on October 31st last year, referred to the late Colonel Waring as follows :—"That fearless public official, that honest gentleman, that thorough engineer and sanitarian."

Colonel Waring is likely to be remembered for his efforts and recommendations, and while this pioneer is borne in mind, it would be in bad taste to pass on without bearing a tribute to Colonel W. F. Morse, of New York. Colonel Morse, for many years past, has been a most distinguished sanitarian : he has been busy in the field of invention, and has designed and built a number of successful cremators, as also hospital destructors, disinfectors and sterilisers. His literary contributions to sanitary science have been many, and are always of interest ; this may also be said of the several papers he has read before Health Associations in various parts of the States.

It is always a pleasing duty, when tracing the development of any innovation which is for the public good, to bear in mind those who have led the way.

Recently it has been my pleasure on two or three occasions to meet Dr. J. B. Cosby, the Health Commissioner for Greater New York, who has been in Europe, and nothing has impressed me more than the untiring zeal and keen interest shown by this eminent public official in our latest British practice.

In the United States, very many more destructors are on the market than in this country, and I take it to be no mean tribute to our British practice that the leading American Commissioner of Health should evince such a lively interest in our methods and results.

About 1,200 tons of civic waste are now produced every day in Greater New York, which has a population of nearly four millions. The responsibility for the public health also being centralised under one authority, it is only to be reasonably expected that the problem to be faced suggests itself to those responsible as being a matter of the highest importance. To emphasise this point it is only necessary to bear in mind that here, in London, we have over 40 distinct sanitary districts, some progressive ; some, well—otherwise ; I need say no more on this, except that I think the general consensus of opinion would be that one authority would be preferable to 40, for many reasons, at any rate.

In order to clearly trace the sanitary progress in New York it is necessary that we should go back for a period of six years.

Up to the year 1894 the refuse of New York City, including garbage and street sweepings, was got rid of in either of two ways, simultaneously. A quantity was dumped on barges at the various receiving places along the North and East Rivers, being subsequently discharged either at sea or on tide lands which had been bulkheaded. The latter method was favoured, being at all times available, whereas, in taking refuse out to sea, trouble was liable to arise in the winter months through stormy weather.

At such times the regular service of barges would necessarily be disorganised, or stopped for many days together, in which case collection must cease, or much offensive material would accumulate at the various depôts. On the other hand, when the refuse was dumped in hollow places for filling up and levelling land, the authorities were again face to face with trouble, the reason being that this source of disposal was only available in the winter. The deposit had to be covered up before the summer heat began with earth and clean ashes, unless the tips were situated in a district altogether devoid of inhabitants.

Grave objection was made to the system of dumping refuse at sea, owing to the beaches of summer resorts on Long Island, Staten Island and New Jersey, having floating refuse of all kinds deposited by the incoming tides. So strong was the crusade against the defilement of the beaches of the summer resorts that it was decided to dump all refuse, from April until October, outside Sandy Hook lightship, or nine miles further from the shore than the previous dumping area. Even now bathers at Long Branch occasionally collide with a mattress or find themselves encased in an old barrel rocking about in the surf.

Further trouble was brewing; the inhabitants of Riker's Island, where quantities of refuse had been tipped behind bulkheads, agitated, with the result that the Legislature decided to mitigate the nuisance to some extent by only tipping refuse there of a less objectionable character.

In February, 1895, a scheme for cremation of garbage and mixed refuse was under consideration, but the promoters could not give sufficient evidence that their cremator would, once and for all, dispose of the refuse—and the question—so it was rejected. But let me say that it would appear that no British destructor was under consideration, but, apparently, an untried American cremator.

Analysis of New York refuse shows an extraordinary percentage of combustible. During 1897 a thorough investigation was made by Messrs. Craven, C. Herschel Koyl and Joseph S. Shinn, on the utilisation of the combustible ash, cinder, etc., in the refuse. It was found that 8,000,000 loads of domestic ashes were collected per annum, equal to 1,200,000 cubic yards, and repeated analyses indicated the yield on the average to be :—

Coal recoverable	20 per cent.
Clinker	15 per cent.
Fine Ash	50 per cent.
Coarse Ash and Stone ...	15 per cent.

(Weight and bulk are approximately proportional.)

COMPARATIVE TABLE OF REFUSE.—COMPILED BY COLONEL W. F. MORSE, C.E., NEW YORK CITY.

		NEW YORK.		LONDON.				BERLIN.		BOSTON.	NEW YORK.
	Authorities ...	CRAVEN.		MAXWELL.		CODRINGTON.		HERING.		O'SHEA.	Components of ashes and per cent. of 100 parts marketable articles in refuse.
	Component parts.	Per cent. by weight.	Totals.	Per cent. by weight.	Totals.	Per cent. by weight.	Totals.	Per cent. by weight.	Totals.	From 140,000 people.	
Ashes.	Coal	16·10	...	·84	...	·15	...	·17	...	75·58	20
	Breeze Cinder	12·07	...	63·69	...	28·80	...	2·64	...		15
	Fine Ash	52·30	80·47	19·51	84·04	52·60	81·55	50·16	52·97		65
	Garbage, vegetable and animal matter	12 20	12·20	4·61	4·61	14·20	14·20	32·54	32·54	20·49	12·20
Refuse.	Paper	5·46	...	4·28	...	...	...	4·26	...	......	74·5
	Rags, clothing, bagging, etc.	·89	...	·39	...	·43	...	1·15	...	......	12·2
	Carpets	·24	...	...	...	...	...	...	...	......	3·3
	Bottles	·18	...	·96	...	·30	...	...	...	......	2·5
	Metals	·15	...	·21	...	·37	...	·20	...	......	2·1
	Tins	·10	...	·79	...	...	...	·58	...	......	1·4
	Leather	·13	...	...	...	...	...	...	...	......	1·9
	Rubber	·01	...	...	...	...	...	...	...	......	·2
	Barrels (whole)	·10	...	...	...	...	...	...	...	......	1·4
	Bones	...	...	·48	...	·25	...	·53	...	......	......
	Wood	...	...	...	...	...	...	·40	...	......	......
	Glass	·03	...	·47	...	...	...	1·27	...	......	......
	Crockery	...	...	·55	...	2·90	...	6·10	...	......	......
	Straw, fibre, etc.	...	...	3·22	...	...	...	...	...	......	......
	Other saleable material ...	·04	...	...	...	...	...	...	...	......	·5
	Totals	...	7·33	...	11·35	...	4·25	...	14·49	3·93	......
	Total percentage ...	100		100		100		100		100	......

Combustible Refuse for Fuel (New York)	60
Incombustible Refuse New York)	5
Marketable Refuse (New York)	35

The first column contains percentages of the 35 per cent. of marketable articles found in New York refuse, here shown for purposes of comparison with other cities. The last column is the same percentages differently expressed. The totals only are given for Boston, no details being reported. The percentages for London and Berlin are based on the whole city collection.

Refuse collected by Street Cleaning Department, NEW YORK (Manhattan and Bronx Boroughs), population 2,948,820, during the year 1898 :—

	Net Tons.	Cubic Yards.
Sweepings	305,800	395,000
Ashes	1,120,800	1,447,700
Rubbish	162,300	930,000
Garbage	170,300	310,500
	1,699,200	3,083,200

ANALYSIS OF NEW YORK ASHES.

It is said that from Manhattan and Bronx Boroughs, New York, there could be recovered 150,000 net tons annually of small coal, thrown away with ashes from domestic and other fires.

ASHES.—ANALYSIS.

Coal, 20 per cent.	Department of Street	Tons.	
Clinker, 15 per cent.	Cleaning collection ...	813,300	47·5 %
Coarse Ash and Stones, 15 %	Permit	308,500	18 %

Ashes from flat houses give :—Coal, 35 per cent. ; clinker, slate and coarse ash, 20 per cent. ; fine ash, 45 per cent.

Ashes from large house furnaces give :—Coal, 40 per cent. ; clinker, etc., 15 per cent. ; fine ash, 45 per cent.

What wasteful people the Americans must be if these figures are correct, and yet, in the face of such remarkable figures, the decision arrived at was that the easiest and cheapest way for the Cleansing Department to handle all the ashes would be to use them for land development. Viewed in the light of modern destructor practice in this country, such a decision is quite astounding.

Having settled on using this part of the city refuse for land development, it was decided to tip it all at Riker's Island (belonging to New York City). The question now arose as to the cheapest and most expeditious mode of transportation. Previously, barges known by the name of "Barney Dumpers" had been used, but their capacity was small, and, not being self-propelling, the rate of progress was slow ; further, much hand labour was involved in discharging their cargo. (See Fig. 34.)

With a keen eye for improvement, the authorities decided to try the "Delehanty Automatic Dumping Boat," proposed by Lieutenant Commander Daniel Delehanty. The first one built —the "Cinderella"—was not satisfactory, but the difficulties were recognised and remedied, and a fleet of these boats were employed. These boats are not used now, but "Barney Dumpers," as here illustrated. (See Fig. 34.)

The carrying capacity of each boat was over 300 tons, and they had a mean average speed of eight miles an hour, the engines indicating 500 horse-power for this speed. The dumping boats are loaded from steel storage dumps with elevators, the dumps being so arranged that a cargo of refuse can very speedily be put into either a scow or an automatic dumper.

When the authorities decided to separate the refuse, sending the least objectionable to Riker's Island, it will be obvious that much that was very offensive would still have to go to sea. Notwithstanding that it had been dumped much further from land, at an increased cost, much continued to get washed up ashore, and, during 1897, complaints were so very frequent and serious that it was necessary to find some other means of disposing of light and objectionable refuse. It was, therefore, determined to erect furnaces at West Fifty Third Street and East Eighteenth Street. The furnaces were on the "Down Draught principle"; the grates were made of water tubes to prevent them burning away. (Fig. 35.)

The furnace had three grates, one below the other, the air space being wide on the top grate and narrow on the bottom one, so that the refuse, as burned and reduced in size to some extent, would riddle through the bars. The gases passed from the furnace through an 80 horse-power horizontal boiler, thence through a fan exhauster, finally passing through a dust separator to the chimney. The exhauster was used to supply an artificial draught and to force the volume of gases through the dust separator. The whole of the clinker and residue was taken away to Riker's Island with the selected refuse.

According to the report furnished by the Superintendent of Final Disposition, the working of the furnaces was quite satisfactory, and the temperature maintained was sufficiently high to prevent any nuisance. Indeed, so satisfactory was the method of disposal, that it was decided to erect a third installation at

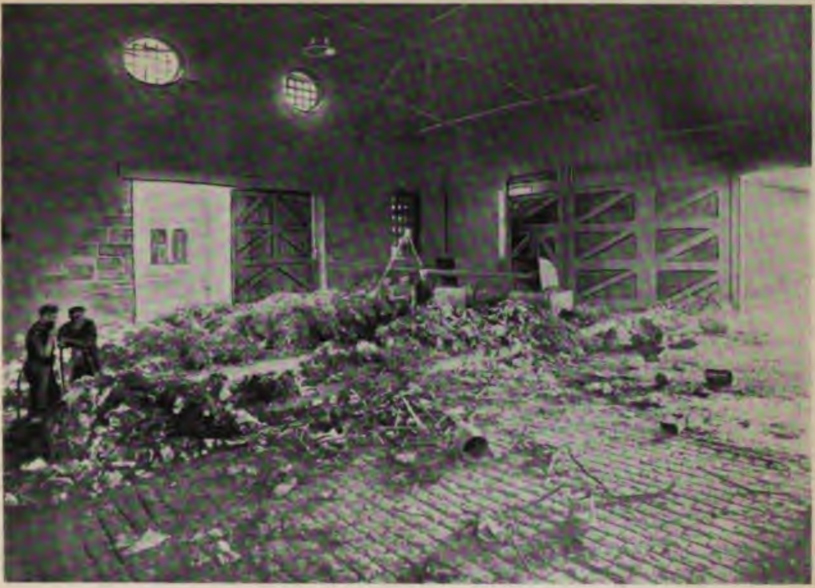


FIG. 32.—DECK OF HORSFALL'S DESTRUCTOR AT POWDERHALL, EDINBURGH, SHOWING INTAKE TO BLAST APPARATUS.

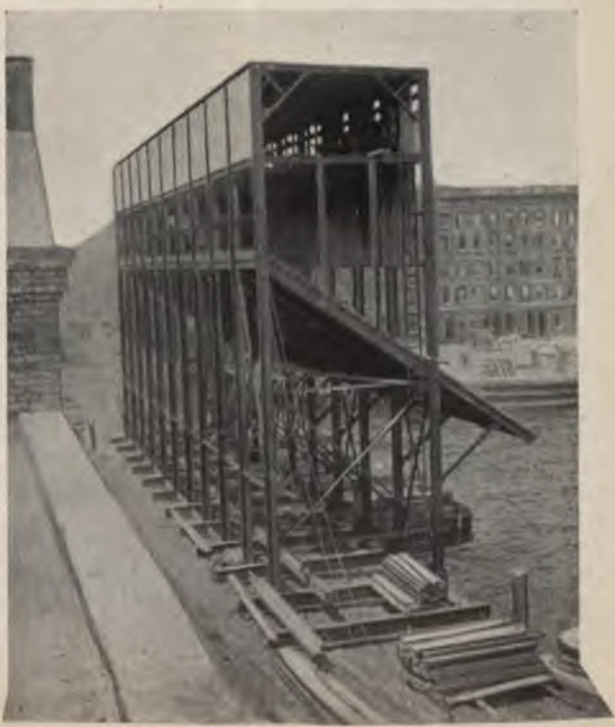


FIG. 33.—STEEL STORAGE DUMP AT THE FOOT OF EAST SEVENTEENTH STREET, NEW YORK.

(To face page 206.)

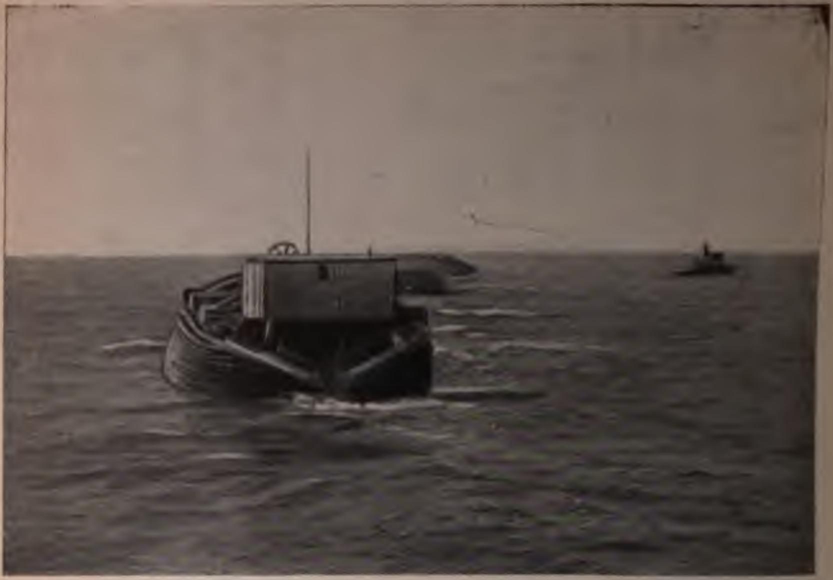


FIG. 34.—TWO "BARNEY DUMPERS" IN TOW, IN ACT OF DUMPING NEW YORK REFUSE.

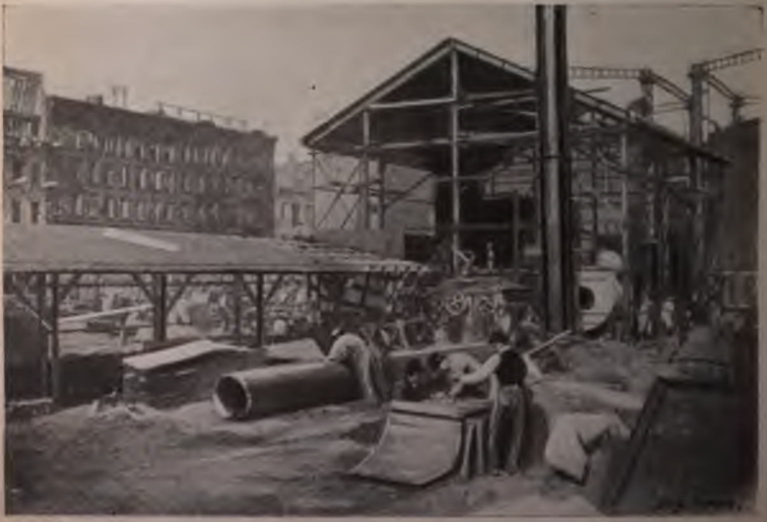


FIG. 35.—REFUSE DESTRUCTOR, EAST SIDE, NEW YORK CITY.

East Forty Eighth Street, but in this instance it was decided to try a furnace of the "Morse-Boulger" type, which had been used to some extent in other cities in the United States, for burning garbage. The Morse-Boulger Destructor is described later in this chapter in connection with the City of Boston.

With the late Colonel Waring's method of classification, and the consequent sale of a proportion of the useful waste, a useful revenue accrues to the city. I am told that an Italian contractor pays the Municipal Government 50,000 dollars a year for the privilege of going through the waste for selected material of value. This process is known as "trimming the scows," the sorting operation being carried on at the dumps where the scows are loaded to proceed to sea. The dumps are thirteen in number, being situated on East Hudson and Harlem rivers. It is said that the scows sometimes dump the refuse as far out as fifty miles, and even then some has been known to come in with the tide; surely a very strong argument against dumping.

While a large quantity of selected and worthless refuse continued to be destroyed in those cremators already referred to, and is still so dealt with, the next move was in the direction of a process of reduction. For the sum of 90,000 dollars per annum a quantity of garbage is removed by scows under contract to Barren Island, where, by a chemical process, the garbage is destroyed, and yields marketable products. As reduction and utilisation is dealt with at some length later in this chapter, I will not refer to it further here. The dead animals go to Barren Island with the garbage. This portion of the refuse is a serious item in New York, the authorities having to deal with something like 100,000 carcases every year.

The reduction plant at Barren Island does not appear to be in favour at all; while cremators can be operated without nuisance, it would appear to be impossible with reduction plants. I understand that the contract between the authorities and the Reduction Company expires a year hence, and it is not likely that the term will be extended.

Having seen what is being done with garbage, and selected and worthless waste, we now come to that most valuable part of the refuse, the unconsumed and only partially consumed fuel, cinder and ash. Strange to say, this is now largely "dumped" a [illegible] nture to think that a great change is not far off

What folly it is to actually pay for throwing away enormous quantities of the most useful part of refuse. When I say useful, I mean, of course, for power production, and at the same time for utterly destroying carcases and objectionable matter without nuisance.

It is really difficult to associate our ingenious friends with such wasteful methods; the refuse of New York is very much richer in cinder and unconsumed recoverable fuel of good calorific value than is the case in this country, and yet our method of burning the whole of the domestic refuse without any sorting is only just beginning to dawn upon Americans as being the most efficient and satisfactory way of solving the problem.

According to the American *Engineering News*, refuse disposal in that country is in a very unsatisfactory condition. One of the reasons adduced is that the problem has not yet been approached in so thoroughly scientific a manner as have other problems in engineering. It is also urged that nearly all the refuse furnaces in the United States have been evolved by mechanics and artisans of an inventive turn of mind, and that the weak points have not been faced but ignored—in short, the inventors, being lacking in capital and anxious to make money, have rather attempted to bolster up a failure than to move slowly in careful experimentary research.

Alluding to the slow progress of sanitary disposal, another writer says :—

> We are only too familiar with the way this question is now handled. After the initial remonstrance and petition for a new order of things—which springs more from the health authorities, who first recognised its importance—comes the somewhat tardy action of the Mayor calling attention to the subject; the tour of inspection by the Council Committee; a deluge of pamphlets, circulars and letters; the keen hunt of furnace builders and ambitious companies anxious to save the city all worry and trouble for a consideration. The contradictory bids, tenders and offers that no man can reconcile, and finally the rejection of everything—and the repetition of these proceedings until everybody is sick and tired of the whole business. The prize at the last falls to him who is longest winded, and the city gets a bad bargain that makes endless trouble in the future.

There can be little doubt that the "Contract System" is responsible to no small extent for the existing condition of matters sanitary in America. It may be very convenient for a sanitary authority to advertise for bids, offering a contract hedged round with most onerous conditions impossible of fulfilment. Or, on the other hand, so exceedingly loose that the contractor does just as much or little as he pleases. I do not think the contract system would commend itself to sanitary authorities in this country. Sanitary matters have a peculiar claim on actual municipal control. In America it is gradually being recognised that municipal control is the correct thing. The inherent mischief of the contract system is mainly that, being awarded in competition, the successful competitor is often compelled to work at a very small margin of profit, giving poor service, causing complaint to be general and annoyance constant.

If a contract is awarded to destroy garbage in a cremator, a similar condition of things is created. The contractor, securing a contract for a few years in competition with others, obviously cannot afford to erect a substantial plant. Compare some cremators here illustrated with our British destructors, and the contention will be clearly demonstrated. The temporary character of the American cremator is at once apparent. What else can be expected? The contractor is not wholly to blame; it is with him a business transaction, a speculation.

He puts up a plant estimated at any rate to last his term, and naturally will not spend any more money than is necessary, because, having spent so much, and having only a limited time in which to recoup himself with profit, he must draw a hard and fast line as to outlay. The system is wrong, not only the contractor, and under such a system it is scarcely possible that destructors or results to compare with our British practice can be realised.

Comparative cost per capita for collection of garbage, under Contract system, and Municipal system :—

UNDER CONTRACT SYSTEM.		UNDER MUNICIPAL SYSTEM.	
Chicago ...	... 24c.	New York ...	... 21½c.
Philadelphia	... 13¼c.	Boston ...	... 22½c.
Washington, D.C.	... 10¼c.	Providence ...	... 15½c.
Detroit ...	... 17¼c.	Milwaukee ...	... 15½c.
Hartford ...	... 13¾c.	Memphis ...	... 31c.
Richmond, Va.	... 7¼c.	Charleston, S.C.	... 18½c.

UNDER CONTRACT SYSTEM.		UNDER MUNICIPAL SYSTEM.	
Montreal	11c.	Cambridge, Mass. ...	25½c.
New Haven ...	8½c.	Los Angeles, Cal. ...	27½c.
Toledo	13½c.	Newport, R.I. ...	20½c.
Richmond, Ind. ...	13½c.	Lynn, Mass. ...	12½c.
Portland, Me. ...	12½c,	Lawrence, Mass. ...	25½c.
Elizabeth, N.J. ...	12½c.	Springfield, Mass. ...	16½c.
St. Paul	8¼c.	Yonkers, N.Y. ...	37½c.
San Antonio ...	30¼c.	Keokuk, Ia.... ...	25½c.
Haverhill, Mass. ...	9½c.	Norfolk, Va. ...	21½c.

Mr. W. W. Locke, Asso. M.A.S.C.E., Sanitary Engineer, in his report to the Brooklyn Health Department in 1896, wrote as follows :—

"The whole garbage question as applied to cities of the United States is as yet in its infancy. The various cities have been content in the past to feed garbage to pigs, or to dump it upon vacant land or at sea, in fact, to get rid of it in any way, providing the method was not too expensive. But the rapid growth of our towns into large cities has resulted in the crowding together of great bodies of people, and the authorities have been compelled to recognise the necessity of diposing of the wastes in a sanitary manner.

"Immediately men with ideas have come forward and represented that they had the only solution of the problem, and they have succeeded in persuading the ever gullible public to invest their capital to carry out these ideas. Contracts have been let for periods of from one to fifty years to dispose of the garbage, when not even an experimental plant had been erected to find out whether or not the ideas were practicable. The result has been almost universal failure. In a few cases where the principles involved were sound the inventors have profited by repeated failures, and now have plants that may be called fairly successful."

Despite continued failure for many years past, the destruction of refuse by fire has been recognised by some few prominent American sanitarians as the only way to dispose of the waste, once and for all. At one time many pinned their faith to reduction processes, but, generally speaking, this system has had its day, and those who most vehemently advocated reduction systems are now readily admitting that destruction by fire is the only solution of this most difficult [illegible]m.

It was not until 1887 that a destructor of any capacity or note was tried on the other side; in that year the "Mann" Furnace, a modification ot the English Fryer type of destructor, was erected in Montreal. A destructor of this type was also used in Chicago for several months, but it was only of small capacity, and after a short existence the destructor was at length destroyed or rendered useless, in one of the fires for which the Pork City is notorious. In 1887 the cities of Pittsburg and Alleghany adopted the Rider Furnace, which I shall have reason to refer to later in this chapter.

Two years later, the city of Wheeling adopted a form of destructor, built somewhat upon the plan of a Siemens' Regenerative Furnace, using gas as fuel. This destructor is said to have done its work well, although no figures showing the capacity or cost of burning have been available. Up till 1892, however, this was the only installation of the type in use. Later it was given a trial in Philadelphia, but here it is no longer used.

THE ENGLE GARBAGE CREMATOR.

This being the first successful crematory to be employed in America, a description of same would doubtless be of interest. The leading principle of the Engle Crematory is the use of two fire boxes, by means of which the fumes or gases arising from the combustion of the garbage are not only destroyed, but are utilised to aid in producing heat, thus obtaining the greatest economy in fuel with the absence of noxious odours.

The Engle Cremator of the larger size is a rectangular brick structure, 35 ft. long, 10 ft. wide, and 12 ft. high. At one end is a chimney 75 ft. to 100 ft. high, the top of the furnace is provided with 4 circular openings, one being large enough (34 in. in diameter) to receive the carcase of a horse. There are platforms at the sides, a little above the level of the top of the furnace, with slopes leading to the feeding holes. The driveways admit to these platforms on both sides, allowing the free access of the collection carts. Over all is a covering house, with sliding doors, and iron roof.

Below the platform in one side of the furnace at each end are doors for fuel, along the same side at the bottom are a range of ashpit doors, through which the ashes are removed, and above these another range, called stoke doors, to admit of the introduction of bars and pokers to stir up the garbage.

Inside, half way from top to bottom, are set the garbage grates, which receive the material fed through the large feeding holes above. The two fire boxes at either end of the interior are on a level with the garbage grate. Below the garbage grate is a hearth dished or sloped to the centre, which catches all liquids passed through the feeding holes and garbage grates, and underneath this is a long flue or combustion chamber connecting with the base of the chimney, controlled by a heavy damper. A similar damper governs the admission of heat from the principal chamber above.

The furnace being charged with the requisite quantity of garbage (say 10 cubic yards), the flames from the firebox nearest the chimney (the upper damper being closed) pass over and through the garbage, driving the smoke and gases into and across the second fire, where they are consumed. The flames from this fire pass down the outside and under this second firebox, and are, by the action of the draught, brought back under the garbage grates on their way to the chimney, where they are discharged.

By the action of this returning fire, the liquids in the hearth are evaporated, and the solid particles burned, the odours of combustion passing through the second fire. The ashes, as they fall through the garbage grates, are raked out through the lower range of doors, and from time to time the garbage is stirred up and distributed over the grates through the upper range of doors. The action of the fire is continuous, and may be carried on for months, without cessation. A part or the whole of the garbage grates being made of pipes with a circulation of water, there is always hot water for cleaning purposes, or steam power can easily be supplied by the grates or an attached boiler.

The construction of the interior walls is of the most solid and massive character. The fireclay bricks are of large size, 12 in. by 9 in. by 8 in., all the openings being protected by solid blocks shaped to fit the apertures. Outside heavy iron buckstays, thrust bars, tie rods and bolts hold every part firmly.

The cost of operation depends mainly upon the quality of fuel employed (this, of course, refers to the fuel which has to be burned to destroy the r[illegible]d, of course, upon the character of material destroyed. The supplementary fuels used seem to be pitch pine wood in the Southern States; in other places, natural gas, also coal, good and bad, with a corresponding variation in the cost of each ton of material destroyed.

The destruction of night soil in furnaces of the Engle pattern has been most successfully done where it has been found necessary. It involves a change in construction which provides a receptacle for the liquid, and the application of the flame and heat in such a way as to concentrate the greatest power upon it.

The first Engle Garbage Crematory appears to have been erected at Des Moines, Iowa, in 1886, but I understand that Des Moines is the headquarters of the Engle Company and that this crematory was only a small experimentary plant.

In six years, this Engle Crematory was adopted by 26 communities, including the following :—Panama, Butte City, Montana, Coney Island (N.Y.), Tampa, Florida, Minneapolis, and Milwaukee.

With reference to this crematory, Dr. Wm. C. Woodward, Health Officer of the City of Washington, in a report to the Honourable Commissioners of the district of Columbia, dated July, 1895, writes as follows :—"The Engle Crematory can, in my judgment, be operated in this City without creating a nuisance. A fume crematory should be provided, however, as in the World's Fair furnace, to aid in securing perfect combustion of the outgoing gases."

Report of operation of double Engle Crematory at Savannah, Georgia, for the month of April, 1892.

Garbage consumed, 4,253 yards : 9½ loads night soil ; 4 goats ; 74 cats ; 39 dogs ; 4,000 lbs. hams and sausages ; 14 barrels of onions ; 4 loads of oranges ; 1 load of bananas ; 2 barrels of meat ; 18 loads of peanuts ; 1 load of potatoes. Infected goods : 7 mattresses ; 3 pillows ; 1 dozen spreads and towels.

A total of 4,774 cubic yards.

An average of 159·13 cubic yards was destroyed per day, at a total cost of 9·1 cents per cubic yard, made up as follows :—

(*a*) The cost of fuel was 2½ cents per cubic yard of garbage destroyed.

(*b*) The cost of labour was 4¼ cents per cubic yard of garbage destroyed.

(*c*) The cost of supervision was 2½ cents per cubic yard of garbage destroyed.

Although digressing slightly, I think it would be of interest to mention, briefly, another specialty of the Engle Crematory Company, known as the Engle Fire Closet. It is mainly interesting because the application is quite unique, and, so far as I am aware, without a parallel in this country. It will, however, be seen that a similar arrangement has been tried in Johannesburg.

The Fire Closet is a brick structure, 18 ft. long by 6 ft. high by 6 ft. wide, exterior dimensions. The walls are built 17 in. to 32 in. thick, lined with the best fireclay brick, and strongly braced outside with buckstays and tie rods. The soil pipes from the closets above, discharge directly upon the grate bars, the liquids passing through to the pan beneath. Valves at the lower end of the soil pipes prevent smoke and flame entering the pipe when fire is applied.

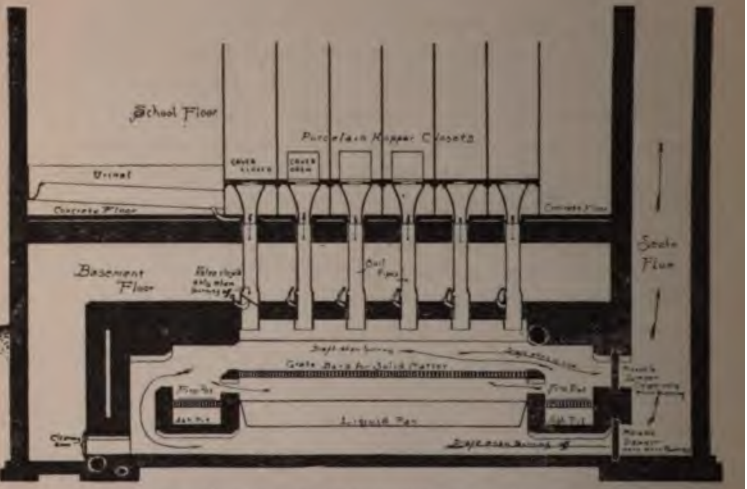


FIG. 36.—SIDE VIEW OF THE ENGLE FIRE CLOSET.

At all times, whether in use or being burned off, the draught is invariably downward through the seats, soil tubes and the upper flue into the chimney, thus no escape of odours or gases can occur. A plan is here shown (Fig. 36) indicating the direction of the draught. It is claimed that only a small quantity of coal is required to deal with the accumulation in the fire closet, and, as a rule, it is arranged for the lighting-up to take place at such periods that the fire shall only be in operation for two or three hours at a time.

A large number of these fire closets have been erected for hospitals, medical schools, quarantine stations, large manufacturing establishments, mills, schools, colleges, etc.

THE SMITH-SIEMANS INCINERATOR.

This incinerator consists of furnaces arranged in pairs around an apparatus for the generation of the gas used for fuel. Each furnace is an upright iron tank, lined on the inside with firebrick, and is connected on one side by underground flues, one leading from the gas generator, and the other to a chimney common to both furnaces of the pair, and on the other side with a short flue to the other furnace of the pair.

The opening for the reception of the garbage is on the top of the furnaces. The ashes are raked out from an opening low down in the side. There is no grate, the garbage resting on the bottom of the furnace and burning only on top. In the flue leading to the chimney is a mass of checker work of fire brick, to ensure complete cremation of the gases. Valves to control the flow of gas are set in the flues. The operation of any pair of furnaces is as follows:—Carts drive to the top of the crematory, depositing all garbage in one furnace, filling it to the proper height. The gas is then made to pass directly from the generator through the flue, where it is mixed with air to assist combustion, to the charged (proximal) furnace. The flame attacks the mass of garbage in it, and then passes through the communicating flue into the empty (distal) furnace, thence to the flue leading to the chimney.

The brick checker work in the flue being incandescent, the gases in their passage to the chimney are perfectly decomposed and rendered free from any objectionable odour. Of course, the distal furnace becomes the proximal furnace for the next load of refuse, the direction of the gases being reversed. The operation of the furnace is, therefore, continuous.

At Atlantic City, New Jersey, one pair of furnaces have destroyed 50 tons of garbage per day. In reporting upon this crematory, Dr. Woodward, of Washington, says that "the only objectionable feature at the time of his inspection was the leaking of water from the garbage around the lower doors of the furnaces, even when closed. This water saturated the soil near by, giving the place a faint, sour smell, characteristic of garbage."

The authorities at Atlantic City have since put down another similar Smith Crematory. This same patent has been adopted in Philadelphia, but since abandoned. Here also water from the garbage escaped from the lower doors, and it would certainly appear difficult to remedy this defect, as the weight of garbage inside must exert considerable pressure.

Here it will be noted again that gas is used to burn the refuse. The cost is said to be small, which is rather vague. It is also claimed that the labour involved is very little, which is likewise vague.

THE BROWN CREMATORY.

This crematory has been in use in Wilmington, Delaware, for some years. The furnace is constructed to burn 50 tons of garbage in 12 hours. It is enclosed in an iron building, and is so constructed that the refuse is discharged into it directly from the cart.

This furnace is about 30 ft. long, 10 ft. wide, and 10 ft. high ; it contains an iron grate of peculiar construction. The furnace is lined inside with fire-brick, and also encased in a water-jacket, to prevent over-heating of the furnace itself. On top are 10 openings, through which the garbage is put in, and on each side corresponding with these are 20 openings, 10 above the grate, through which the garbage is levelled, and 10 below, through which the ashes are drawn. The chimney is situated at one end, and the fire is fed at the same end.

Here, again, a supplementary fuel is used to destroy the refuse, in this instance petroleum. This is fed through a burner ; a blower is used for accelerating combustion, the air being taken from inside the building.

The carts empty their contents directly into the furnace. Falling on the grate, the garbage is at once attacked by the flame, both above and beneath. The fire can be levelled from the openings in the side, and the residue is withdrawn from the lateral openings below the grate.

THE RIDER CREMATORY.

These cells were erected at Alleghany and Pittsburg. At the former place, it is said that for the destruction of each ton of refuse one bushel of coal is required. At Pittsburg, the fuel used for this purpose is natural gas. The furnace seems to be constructed on similar lines to other American types already described. The cells are fed at the top, but, for some reason difficult to fathom, the openings are only 15 inches in diameter. Small dead animals are burned, but it is, of course, impossible to deal with large carcases without mutilating them first.

At Alleghany, this type of crematory has been in use for many years, apparently with thorough satisfaction to the authorities. At Pittsburg the system has been in use even longer. I understand Professor C. H. Haswell, in a report on these two installations, writes as follows :—"The work done by this furnace was, I am satisfied, done as well as it is possible for any furnace to do it under the existing conditions. I do not feel justified, however, in forming any opinion as to their ability to burn such garbage as is collected in Washington."

THE DIXON CREMATORY.

The first crematory erected by this Company was at Atlanta, Georgia. In this instance the plant was erected by arrangement with the authorities to be operated for one year before payment. If, at the expiration of that time, it was not satisfactory, the Company agreed to remove it without any cost to the city.

To describe the crematory briefly, it is 64 ft. long, and consists of two independent furnaces, each 32 ft. in length ; it is constructed of brick as far as practicable. For the operation of each furnace three fires are employed, one, a coke fire, placed in the flue, where it will burn off all the vapour given off from the fire. The other fires are both of coal, one playing above and another beneath the grate on which the garbage rests.

The carts enter on the second floor of the building, and empty the garbage directly on to the grate in the furnace, through two openings on the top. Each opening is provided with a metal cover, arranged so as to be easily handled by one man. The ashes from the garbage are drawn on the first floor through doors on the side of the furnace. All furnace fires are fed and drawn on this floor. The chimney stack is of brick, and 60 ft. in height.

Of course, the coal fires and also the coke fume cremator in the flue have to be started fully an hour before the first load of refuse is due to arrive. Thus it will be seen that a large quantity of supplementary fuel is necessary to deal with the material to be destroyed.

Night soil is dealt with in this crematory; it is emptied into the furnace in the same way as garbage. The liquids are rapidly evaporated and absorbed, and all the escaping gases pass into the combustion chamber, being rendered innocuous by the intense heat maintained there. The entire furnace inside, from the iron fronts to the top of the stack, is of firebrick, and no machinery, pipes, valves, or dampers are used; no skilled labour is necessary to operate the furnaces.

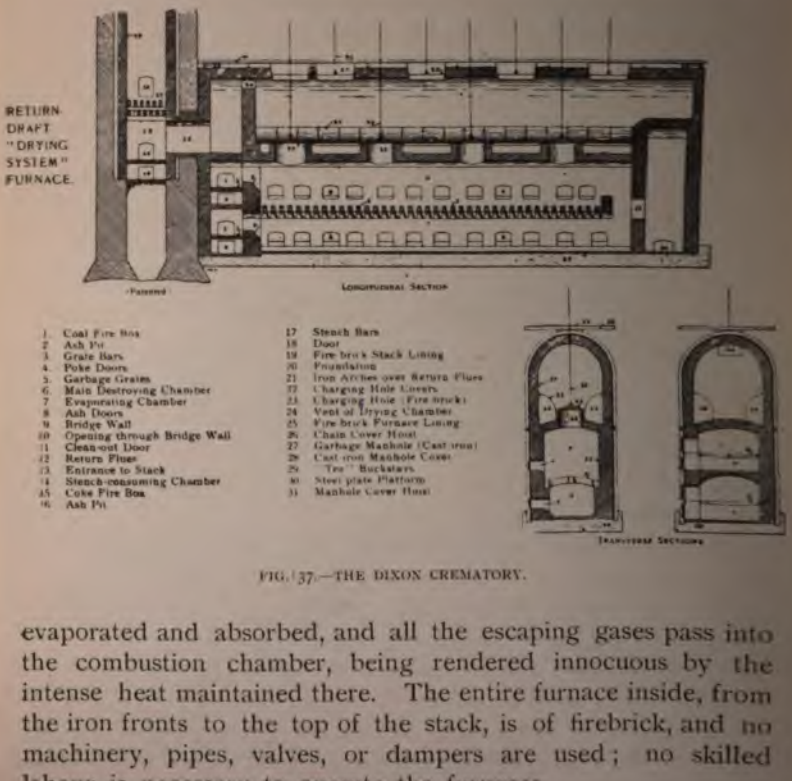


FIG. 37.—THE DIXON CREMATORY.

The cost of cremation varies in different cities, according to variable conditions, the cost of fuel, coal, wood, gas, or oil, the price of labour, the condition of the garbage when collected, and

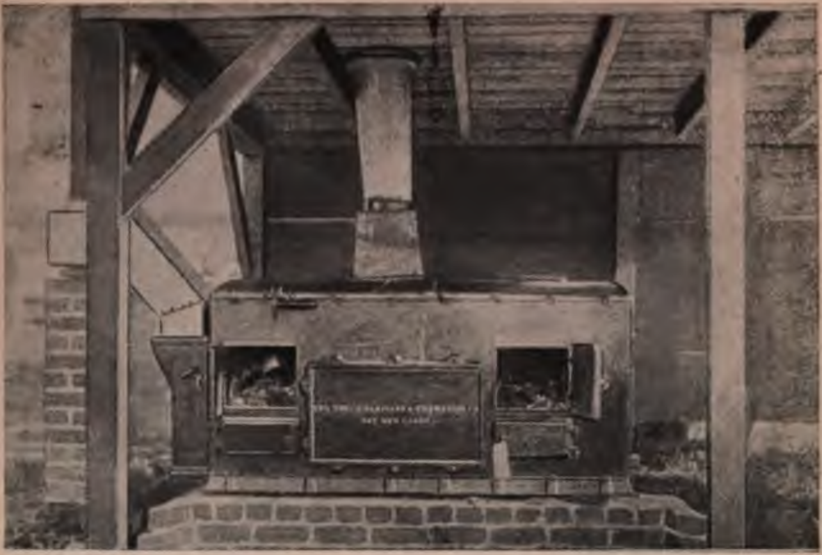


FIG. 38.—THE ENGLE PORTABLE FIRE CLOSET, AS USED AT THE STATE FAIR, DES MOINES, IOWA, ETC.

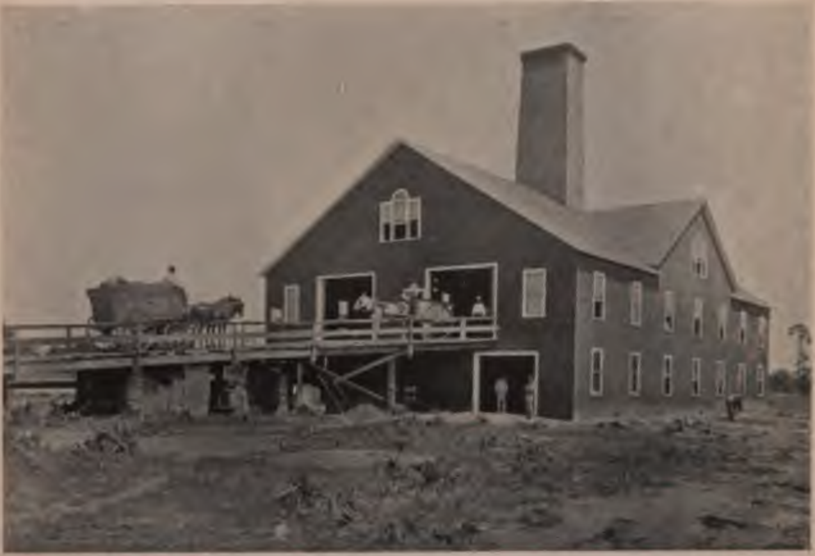


FIG. 39.—EXTERIOR GENERAL VIEW OF DIXON CREMATORY AT JACKSONVILLE, FLORIDA.
CAPACITY—100 TONS PER DAY.

(To face page 218.)

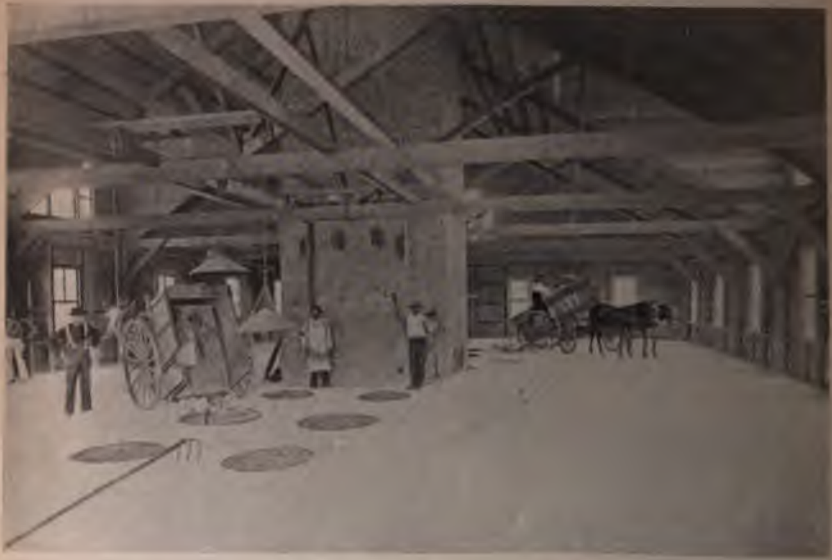


FIG. 40.—TIPPING FLOOR OF DIXON CREMATORY AT JACKSONVILLE.

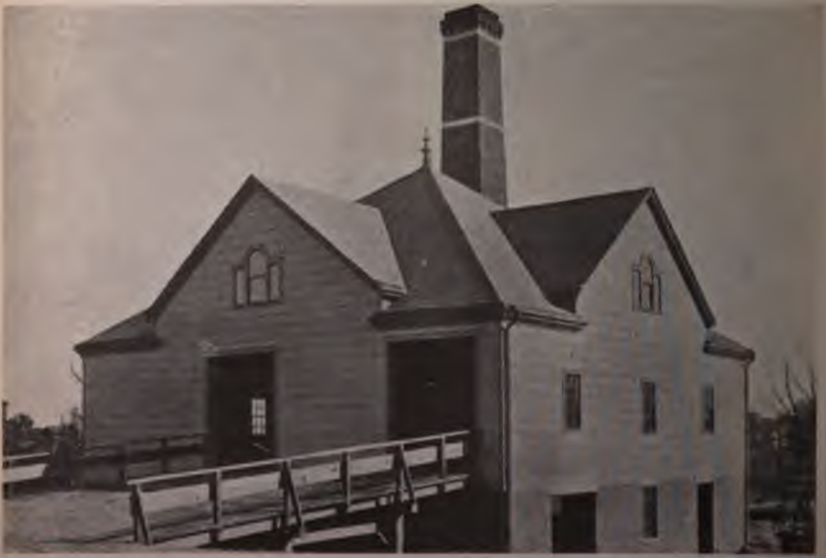


FIG. 41.—THE DIXON CREMATORY AT FORT WAYNE, INDIANA.

the composition of same ; further, whether night soil is burned or not. The price of fuel covers a wide range ; for instance, coal dust or slack in Pennsylvania and natural gas in Indiana reduce the cost of cremating mixed garbage to 17 cents. per ton, including labour, while in the South coal costing two or three dollars per ton raises the average cost considerably.

In three Southern cities the average cost, including labour, is said to be 34 cents. per ton. In California, where crude petroleum is used as a supplementary fuel, the cost per ton is officially reported to be from 48 to 55 cents. per ton. In three cities of New Jersey and Delaware the cost per ton averages about 45 cents., including labour.

Mr. H. A. Andrews, of Atlanta, Georgia, who is an American sanitary expert, says, in speaking of the Dixon and other crematories, that "a third furnace of intense heat, through which the offensive gases and vapours must pass, is an absolute necessity."

REPORT OF BOARD OF HEALTH OF THE CITY OF ATLANTA, GEORGIA, FOR THE YEAR 1897.

The Dixon Crematory has done excellent service during the year, and from a sanitary standpoint has proved eminently successful. The cost of cremation, however, is considerable, amounting to about 34 cents per ton.

Report of Crematory.

Garbage and Night Soil Burned.

Number of cart loads garbage	17,160
Number of waggon loads night soil	2,670
Number of waggon loads garbage	5,470

Dead Animals Burned.

Number of dogs	4,344
„ „ calves	80
„ „ sheep	40
„ „ hogs	23
„ „ goats	24
„ „ yearlings	6
„ „ cows	2
„ „ horses	2
„ „ colts	4
„ „ pigs	4
„ „ alligators	2
„ „ monkeys	1
Coke and Coal Consumed	1,406½ tons

Dixon Crematories have been adopted at the following places :—

Dayton, Oregon.
Jacksonville, Florida.
Los Angeles, California.
Trenton, New Jersey.
Atlanta, Georgia.
Lafayette, Mississippi.
Santiago, Cuba.
Youngtown, Oregon.
New Orleans, Louisiana.
Elwood, Indiana.
York, Pennsylvania.
Bridgeport, Connecticut.
Rapides Parish, Louisiana.
U.S. Government, West Point, New Jersey.
Charlotte, New Jersey.
Memphis, Tennessee.
Wilmington, Delaware.
Camden, New Jersey.
Fort Wayne, Indiana.
San Diego, California.
McKeesport, Pennsylvania.
Greater New York.
Greenville, Mississippi. &c.

Plans of the Dixon Crematory are here shown, and also illustrations of the Dixon Crematories at Jacksonville, and at Fort Wayne, Indiana. (See Figs. 39, 40, and 41.)

THE BROWNLEE CREMATORY.

This type resembles very closely in general principles that just described, the Dixon. It is so arranged that the material to be burned is dumped into openings in the top, falls on to the grate, and is subjected to the action of a fire passing over it away from the flues. Here also with this type a third fire is located in the flue to cremate offensive effluent gases. The bottom of the furnace pit is filled with sand to absorb water finding its way through the grate so as to permit its slow evaporation.

A crematory of this type has been working for three or four years past at New Brighton, Staten Island ; the same type was also adopted at Terra Haute, Indiana, and Gainsville, Texas, but I am told these are not now in use.

THE THACKERAY INCINERATOR.

This type is unique and from many points of view one of the best destructors in America ; in the first place, it is claimed that it is the only American destructor which does its work wholly without the aid of any supplementary fuel other than the refuse.

Although not generally known by destructor engineers in this country, the Thackeray Incinerator at San Francisco is the largest destructor plant in the world, having a capacity of 700 tons per day ; further, it is interesting to note that Mr. Charles Thackeray, the inventor, is an English engineer.

The first Thackeray Incinerator was erected in the City of Montreal some six years ago; it is of a capacity of 150 tons per day of 24 hours; this quantity is consumed in 12 cells, each with a grate area of 72 square feet. A test made in 1894 showed that it was possible to burn refuse at the rate of 40·27 lbs. per square foot of grate per hour, the average cost per ton burned being 14·4 cents.

The large destructor at San Francisco commenced working in September, 1897; the buildings consist of two incinerating houses with the chimney between. They form together three sides of a square 265 ft. long by 95 ft. wide, and two stories in height. There are 16 cells in each building, each with a grate area of 96 square feet, making a total grate area of 3,702 square feet. Each cell has a capacity of 20 tons per 24 hours. It is claimed that the cells are the largest in the world, and there are four crematory furnaces for the cremation of fumes, with a capacity of 15 tons, but we are not told what is used for the fume cremators in the way of fuel.

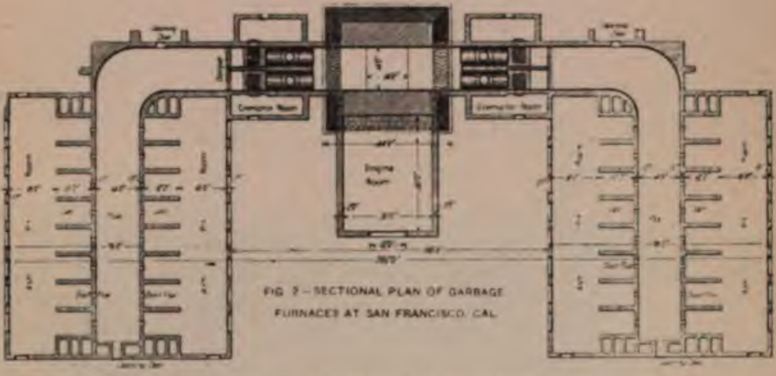

Engine Room
FIG 7—SECTIONAL PLAN OF GARBAGE FURNACES AT SAN FRANCISCO, CAL.

FIG. 42.—THE THACKERAY INCINERATOR.

The chimney is 265 feet in height, with a concrete foundation 50 feet square by 3 feet thick. From the top of the concrete to the ground line it is solid brickwork 47 feet square, and steps back to 32 feet are 12 feet high. The trunk is 30 feet square by 40 feet high, with walls 8 feet thick from the top of the trunk to the top of the house. The walls are built circular 210 feet high, which makes it 265 feet from the base. The flue is lined with firebrick 50 feet high, and topped with a cast iron cap of special design. It is claimed that this is the tallest largest chimney ever built to dispose of refuse and garbage gases. All the buildings are built with solid brick walls, with galvanised iron roofs and cast iron furnaces, grate bars and hoppers. They are very substantial buildings, the workmanship has been executed in a first-class manner, and the whole works are thoroughly fireproof, doing away with the necessity for insurance.

The inclined roadways, platforms, office, and buildings cover an area of 400 ft. by 200 ft. The carts drive up the inclined roadways to the top of the building, and there dump their contents into chutes leading direct to the hoppers, through which the refuse is fed into the furnaces.

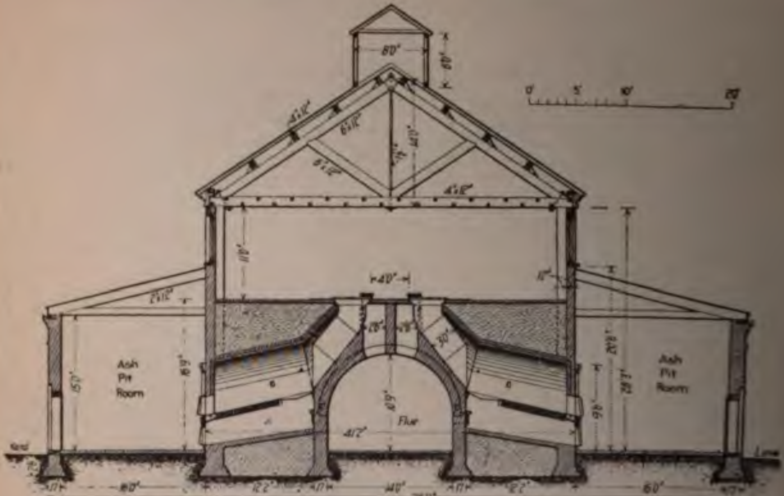


FIG. 43.—CROSS SECTION OF THACKERAY FURNACES AT SAN FRANCISCO.

When the works were inaugurated a three weeks' test was made, the average quantity of refuse destroyed being 350 tons per 24 hours. The test was in every way quite satisfactory; there was an utter absence of gases, fumes, odours, or noxious vapours in and around the works.

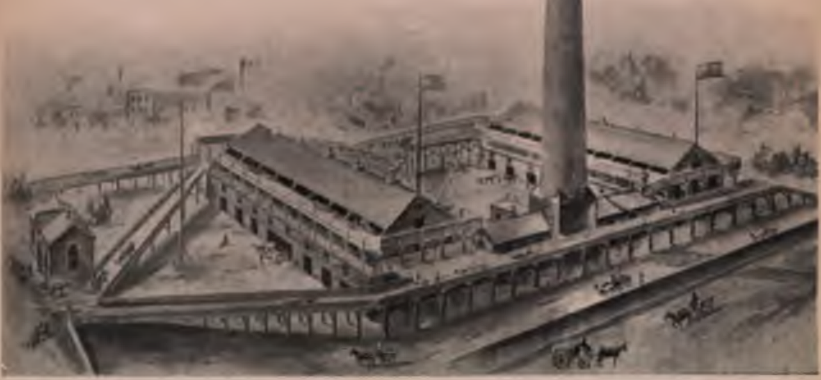


FIG. 44.—GENERAL VIEW OF THE THACKERAY GARBAGE DESTRUCTOR WORKS, SAN FRANCISCO, CAL.

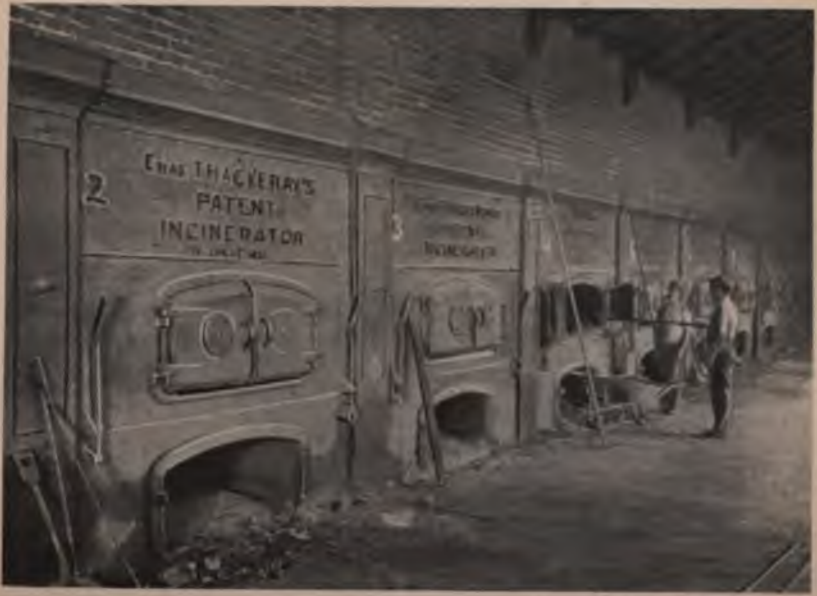


FIG. 45.—FRONT VIEW OF THACKERAY GARBAGE FURNACES AT SAN FRANCISCO.

(To face page 222.)

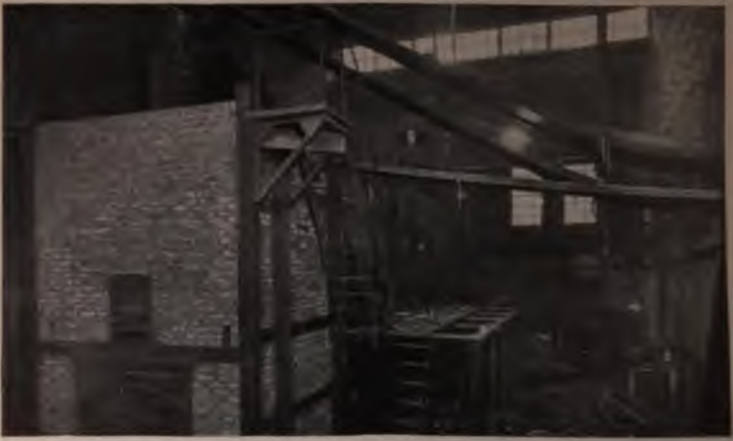


FIG. 46.—THE MORSE-BOULGER DESTRUCTOR AT BOSTON.

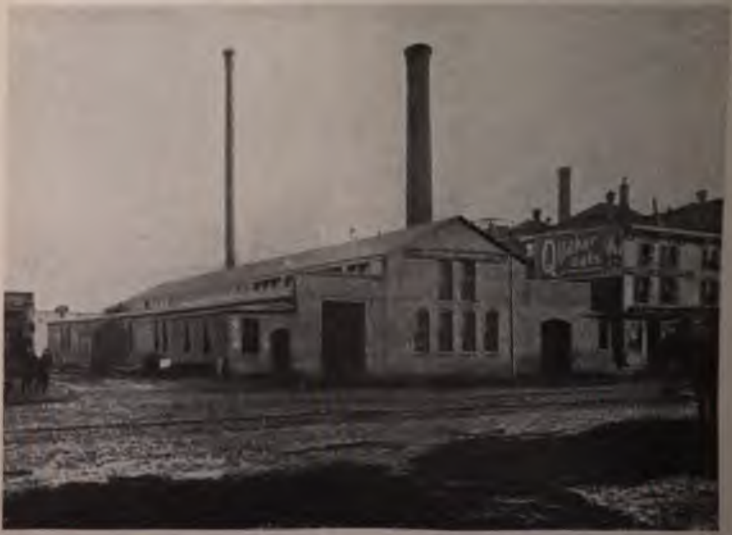


FIG. 47.—MORSE-BOULGER REFUSE DESTRUCTOR ON ATLANTIC AVENUE, BOSTON.
(THE CHIMNEY ON LEFT SIDE OF PICTURE IS USED IN CONNECTION WITH THE CELLS.)

The following is an analysis of the ash and clinker made during the test run :—

	Ashes per cent.	Clinker per cent.
Unconsumed carbonaceous matter	1·82	6·74
Silicon Dioxide	51·91	45·54
Iron Sulphide	2·73	0·75
Copper Sulphide	0·80	trace.
Lead Sulphide	0·48	,,
Phosphoric acid	0·81	2·52
Aluminium Oxide	1·430	12·71
Iron Oxide	1·00	1·92
Calcium Oxide	15·45	19·59
Magnesium Oxide	1·89	1·26
Potassium Oxide	0·82	1·46
Sodium Oxide	1·73	0·83
Sulphur Trioxide	1·64	4·10
Carbon Dioxide	3·94	2·34
Loss and undetermined	0·62	0·24
Total	100·00	100·00

It is reported that when once the works were started the fires were kept going continuously for 18 months, and that the furnaces then showed no deterioration nor were any repairs needed.

Some plans and illustrations are here shown of the Thackeray Incinerator at San Francisco. (See Figs. 42, 43, 44, and 45.)

THE DECARIE GARBAGE INCINERATOR.

This is the most recently introduced incinerator on the other side, and so far only one installation has been made, this being a portable steel incinerator, of a capacity of 20 tons per 24 hours, erected at the town of Westmount, near Montreal. It is claimed for the Decarie Patent that all refuse is thoroughly destroyed without the use of coal or oil as a supplementary fuel. Further, that it is a steam raising plant, although no very extravagant claim is made in that direction, 3 to 5 I.H.P. per ton of refuse only being promised. A plan is here shown of a side external view of this incinerator.

The generation of steam power, the burning of the refuse without the use of other fuel, and the automatic separation of clinker and ashes are some of the leading features of the Decarie system, as also the ingenious arrangement for conveying the material from the drying chambers to the cremator chambers. To briefly describe the cremator, in each of the cremating chambers there is a pair of upwardly convergent tubular or hollow garbage supporting grates, arranged transversely from side to side of the chamber.

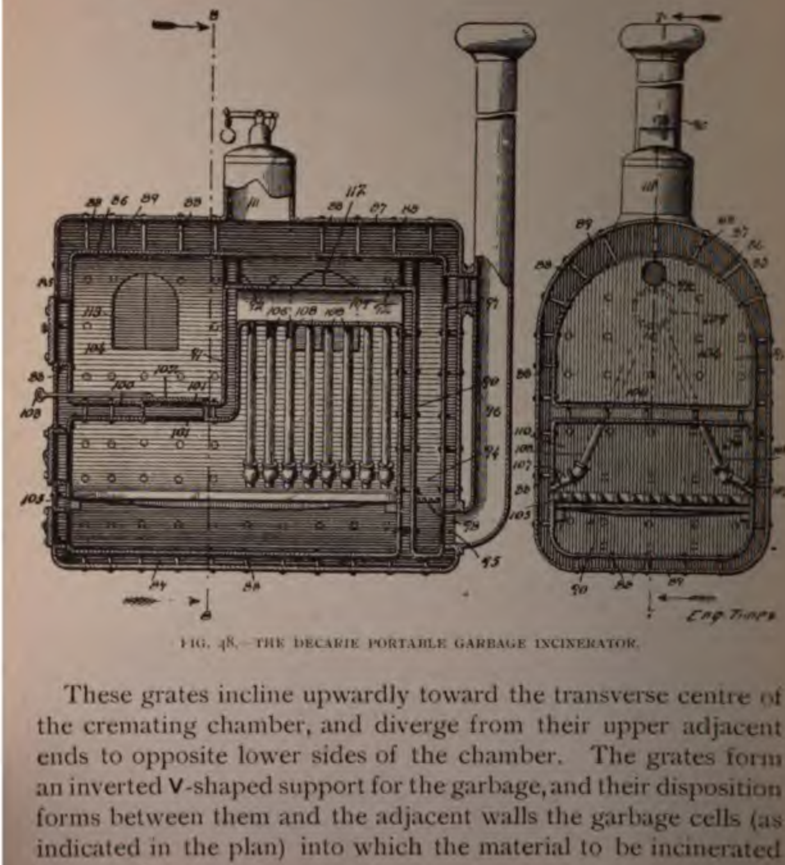
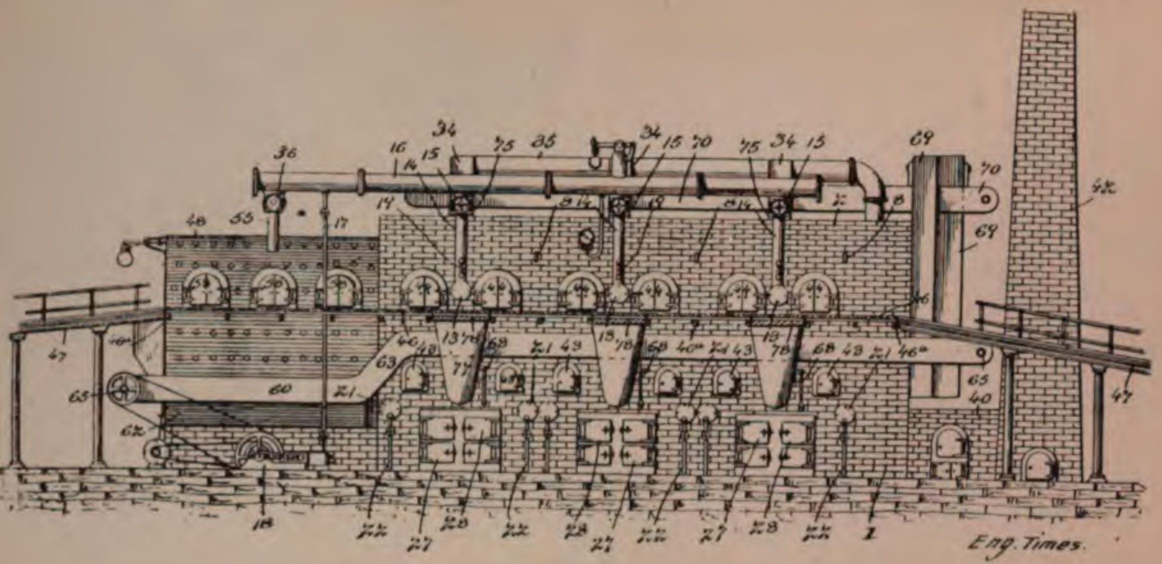


FIG. 48.—THE DECARIE PORTABLE GARBAGE INCINERATOR.

These grates incline upwardly toward the transverse centre of the cremating chamber, and diverge from their upper adjacent ends to opposite lower sides of the chamber. The grates form an inverted V-shaped support for the garbage, and their disposition forms between them and the adjacent walls the garbage cells (as indicated in the plan) into which the material to be incinerated is dumped.

The tubes supporting the garbage supporting grates are fitted



Eng. Times.

FIG. 49.—THE DECARIE INCINERATOR, ORDINARY TYPE, LONGITUDINAL SECTION.

at their upper end in the lower side of an upper centrally arranged distributing header drum, extending transversely across the cremating chambers, and projecting through the opposite side walls of the furnace casing. The opposite ends of this distributing header are fitted to the lower ends of the oppositely arranged steam conducting pipes, provided with suitable valves, and connected at their upper ends with the steam drums, arranged longitudinally above the furnace casing, at opposite sides thereof, to provide for the pipe connection with the projecting ends of the distributing headers within each of the series of the cremating chambers.

It will therefore be seen that the upper steam drums serve to collect and store the steam generated within the tubular garbage grates, so as by means of suitable pipe connections steam can be supplied to an engine, or used for any other purpose desired.

An integral part of the Decarie is the "Scent Consuming Furnace" (our old ally, the fume cremator, with a genteel name). We are told that a fire is constantly maintained on the grate of this, but we are not told what fuel is used for consuming the noxious fumes on their way to the chimney.

THE McKAY INCINERATOR.

The only example of this type in use is at Yonkers, N.Y. (population 38,000.) The McKay, while retaining many of the characteristics of the American type of furnace, possesses a new feature in the introduction of an additional garbage grate.

The upper garbage grate is set on a level with the bridge wall of the upper fuel grate. The upper garbage grate is about 16 ft. long by 4 ft. wide, the upper fuel grate about 6 ft. long by 4 ft. wide. About 5 ft. below the upper garbage grate is located the lower garbage grate, which is about 15 ft. long and 4 ft. wide. The lower fuel grate is 5 ft. long and 4 ft. wide, and is on a level with the lower garbage grate, being separated from it by an 18-inch bridge wall. Beneath the lower garbage grate is an ashpit, about 2 ft. deep. The upper garbage grate bars are constructed so as to rotate about an axis, the bars are of cast iron, and in section resemble a three-pointed star. One end of the grate forms a hub, in which is a square cored hole ; the other end of the bar terminating in a journal.

The grate is supported in position by placing the journal end in a half pillow block, and then passing a circular steel rod with square end through the walls of the furnace, one end of the rod entering the cored hole, the other projecting a few inches beyond the outside wall. By fixing a crank handle at the outside end of the rod the grate may be rotated. The lower garbage grate is fixed and stationary.

The garbage is introduced through three openings in the top of the furnace, located at intervals over the upper garbage grate. Two of the charging apertures are 2 feet in diameter, the other 3 feet, and are closed when not in use by cast iron circular flanged covers.

The travel of gases is in the usual direction, being from the upper fuel grate up, and over, the upper garbage grate, then downward, mixing with the products of combustion from the lower fuel grate, both passing between the two garbage grates to the main flue. The upper garbage grates form drying hearths, the partially burned or dry garbage being dropped at intervals upon the lower or fixed grate by simply revolving the rotating grate, there to remain until the process is complete, the residue then being removed from the ashpit doors.

Joseph B. Taylor, Inspector of Offensive Trades, Brooklyn, in reporting to the Health Department, *re* the McKay, remarks as follows :—

"The furnace is well constructed and in principles is equally as good as others of this type ; grates exposed to heat on both sides are generally a source of trouble ; in this particular instance their life is said to be one year. During the time that this furnace was under observation its temperature was by no means as high as it should be for proper incineration, although the ash seemed to contain no unburned organic matter."

SMITH-VIVARTTAS INCINERATOR.

Only two incinerators of this type have been adopted, one of six cells at Scranton, Pennsylvania, with a capacity of 35 tons, and a smaller plant at Plainfield, New Jersey.

The Smith-Vivarttas has a number of novel features, and will be found to differ materially in design from others. It is also unique in the fact that artificial draught is requisite for its operation. The incinerator is built up from the cell as a unit, the cell being rectangular in horizontal section, the longest dimension being the vertical depth.

The cells adjoin and are arranged on one or both sides of a central and common combustion chamber. The bottom of each cell is inclined downward towards the combustion chamber, forming a sort of stepped hearth, communication being established between combustion chamber and cell by means of an arched opening. In the combustion chamber on the side opposite to the cell opening, is built a hollow triangular-shaped piece of brickwork extending the full length of the cells, the apex of which is in a line with the bottom of the inclined cell hearth, thus reducing the width of the combustion chamber by about two-thirds at this point.

A fuel grate is built at one end of the combustion chamber, and a steam boiler is set above the grate. To start the incinerator, a coal fire is started on the fuel grate, and the sheet-iron covers on top of cells being removed, the cells are then charged with garbage. As soon as the steam pressure in boiler permits, the blower is started : a portion of the air supply is delivered by a branch under the coal-fired grate, and the remainder into the combustion chamber proper. A secondary combustion chamber is provided to ensure a further intermingling of gases and conduce to thorough cremation.

In the case of Scranton, the garbage not being collected by the Municipality, the delivery is very irregular, the plant might be running at full capacity one day, and almost idle the following day, a condition of affairs which cannot be said to be conducive to economy in fuel or labour.

THE ANDERSON INCINERATOR.

This type was in use at Chicago, Illinois, for a short time. It was modelled after a certain form of brick kiln. It consists of a long masonry tunnel with a grate at one end connecting with a chimney at the other end.

Through the centre of the tunnel tracks are laid, upon which run flat cars, having the platforms covered with brick, and fitting the tunnel close on the sides. The cars have their platforms loaded with garbage and are then run into the incinerator, entering at one end and leaving at the other. When the incinerator is in full operation the tunnel is completely filled with loaded cars, and as the contents of a car near the furthest end is reduced to ash, doors are opened and a fresh car is run in, pushing all the cars along the tunnel, the furthest car being pushed out of the tunnel to be reloaded, and enter at the other end again, when the incinerator is ready for another charge.

The destruction of the garbage is secured by passing the products of combustion from the grate over the contents of the cars from one end of the tunnel to the other. This very novel arrangement has not been successful at Chicago, I am told, and it has not been adopted by any other city.

UNITED STATES GOVERNMENT INCINERATOR.

A number of these are in use at the Army posts. They are not usually called upon to destroy any considerable quantity of garbage per day, probably not exceeding four or five barrels: the furnaces being built of very much larger capacity than this are only operated for a short period each day.

To briefly describe the type. They are made either in the form of a single cell or a double cell with a common chimney. The cell has about 25 square feet of grate and is 7 feet in height, the lower part of the cell tapering down to a fuel grate 3 ft. by 3 ft. Situated above the fuel grate are two garbage grates forming an angle of about 45°, the apex of the angle being uppermost, but leaving a small space between the grates at this point. The grate bars are of the ordinary type, the upper and lower ends of each set resting in cast-iron bearing bars built in the masonry. The lower bearing bars are so located as to leave a space of 10 inches between the bars and the cell wall. When the grate bars are in place two wedge-shaped pockets are formed in the space between the grate bars and side walls.

In the back wall of the cell and directly above the apex of the grates a 14 inch by 14 inch flue is built which connects with the chimney. The furnace is operated by starting a fire on the fuel grate, and filling the two side pockets referred to already, through two charging holes in the top arch, an opening being arranged over each pocket. The garbage is dried and as reduced falls through on to the fuel grate, but here again with the garbage grate it will be seen that there is fire above and fire below, which must be severe on the bars.

BURNS' INCINERATOR.

This is rectangular in form, about 8 feet square, inside dimensions, and 18 feet in height. Two horizontal fuel grates are arranged near the bottom, separated by a bridge wall, each grate having its independent fire and ashpit doors arranged on opposite sides of the furnace. Extending from above the grates to the top of the furnaces are a double series of inclined fire-brick arches, arranged in a manner similar to the plates in a gas scrubber, each alternate arch having an open space between the end and the side wall. Near the top of the incinerator, are two flues which convey the gases into what is called the combustion chamber, the gases passing out of the bottom by a flue to the chimney. The garbage is raised to the top of the cell by a conveyor which delivers it into an iron hopper. In the bottom of the hopper is a counter-balanced door, which discharges the garbage automatically, directly a sufficient quantity has been tipped into the hopper to overcome the counter-balance weight.

From the hopper the garbage falls upon and between the fire-brick arches, forming a column of garbage up the centre of the cell, this being exposed to the ascending currents of hot gases from the coal-fired grate at bottom of cell. The residue is withdrawn through doors in the side of the cell near the bottom.

Only one incinerator of this type appears to have been erected, that was at Brooklyn, New York, in 1896, at a time when a contract had only a short time to run out. With the expiration of the contract the incinerator was used no more; while in operation about 20 tons per 24 hours were dealt with.

ROTATING FURNACE.

Although the idea of the rotary furnace is old, the type has not been adopted to any extent for cremation purposes. It has been extensively applied for metallurgical roasting processes, and also for direct heat drying. The general principle of the rotary furnace, as applied to destructor work, consists in cascading the refuse by means of an inclined revolving tube, lined by firebrick; the only one of the type in England is the Willoughby, which is described and illustrated elsewhere.

Of the two forms of American rotating furnaces which will be mentioned here, one has never been actually used as a garbage furnace, and the other was only operated for about a year; they are interesting, however, to examine briefly, as illustrating two different methods in rotating furnaces.

HOGAN INCINERATOR.

While up to the present this furnace has not been applied to garbage incineration, it has been used in several instances for calcining certain chemicals. As regards the revolving cylinder, that is much the same in principle and design as described with the Willoughby Destructor. It is set at an incline so that any material fed in the upper end is gradually discharged, by the rotating motion of the cylinder, at the bottom end.

At the upper end of the tube or cylinder is a garbage receiving tank, a screw conveyor works in connection, the other end of conveyor being in the end of the cylinder; the garbage is thus gradually fed into the cylinder top, then at the bottom end is a steel furnace, moveable on wheels, and water jacketed so as to act as a boiler as well as a furnace. The idea of having the furnace on wheels and on a track, is so that it may be readily run back at any time to give easy access to the tube.

The furnace is intended to act as a cremator, and after the gases leave there they pass through the cylinder into a water condenser, thence to the chimney; draught is maintained by an exhaust fan.

McGIEHAN INCINERATOR.

This furnace was erected in Syracuse, New York, and was operated for a few months only, the owners of same, being unsuccessful in securing the contract, abandoned it.

To briefly describe it, the arrangement was a firebrick lined tube or cylinder, five feet inside diameter and thirty feet in length, mounted on three pairs of friction wheels, and arranged to be revolved on a pair of level gears, the whole being c on beams. The lower end of the tube projected into a furnace with a plain grate. The other end of the tube ent a brick down-take, which also served to support a sheet hopper for discharging into the revolving tube.

Rivetted to the interior of the tube are six T beams arrang symmetrically and parallel with the axis of the cylinder, th purpose being to raise and cascade the garbage in a mo thorough manner than would otherwise be possible witho them. For fuel purposes, oil is relied upon, being blown int the furnace just over the fire-door; an independently fired boiler provided power for revolving the cylinder, and also steam for the oil jet.

Generally speaking, although this type of furnace and cylinder has done good work in direct heat drying and for other special work, they are not looked upon in America as successful in economic cremation, the depreciation and repairs being serious, and occasionally the mechanism would seem to be a very troublesome factor indeed.

Having now given a brief resumé of a number of cremators or incinerators which have been employed in various parts of the United States covering a period of ten years, we will now look into more recent practice. As an example, we cannot do better than take such an installation as that erected for the City of Boston, and known as the "Boston City Refuse Disposal Station." This plant having only been in operation since January 23rd, 1899, it may be said to represent modern American practice.

The plant is located on the ground formerly occupied by the Steam Heating Company, at 462, Atlantic Avenue, immediately adjoining the Fort Hill Wharf Dump and the Edison Electric Company, and only about half a mile from the City Hall. The buildings comprise a main central house, 162 feet long and 40 feet wide, and on each side a storage shed 20 feet wide and the same length. The central house is supported on steel columns, having a clerestory which affords light and ventilation. The walls are of brick and the roof of wood, with a fireproof covering. The building is divided into two rooms by a partition wall of brick, shutting off the furnace from the packing room. Through he centre of the main room runs an endless belt or steel apron feet wide and 150 feet long, between centres. This is carried on chain rollers supported on a steel frame. The first 25 feet of this belt is at the ground level, the next section is two and a half feet above the floor, and the last 35 feet rises on an incline, 30 feet discharging into a bin placed behind the rear wall of the building.

On each side of the level track, which is 90 feet long, are placed hoppers or picking bins, into which are put the various classes of paper, rags, cardboard, and other articles which are to be dealt with. Below the hoppers are six baling presses, each capable of compressing a bale of paper weighing 450 pounds in fifteen minutes. The city carts enter from the street, passing over a weigh bridge where each load is weighed, then discharging their contents upon the conveyor. The mixed mass of material then passes between the hoppers, where lines of men are stationed who take out the several kinds of paper or rags allotted to each press, placed in the basement below the hoppers.

There are six classes or separate kinds of paper and cardboard, four or five of rags, besides clothing, carpets, leather, rubber, bottles of all kinds, tin cans, wood, and a great variety of miscellaneous articles.

Across the building, behind the fireproof wall, is placed a "Morse-Boulger" Refuse Destructor; this is a cremating furnace 50 feet long, 13 feet high, and 10 feet wide. On the top are two feeding holes, through which the refuse from the end of the conveyor is conducted by means of a chute into either hole as may be desired. This forms a continuous supply of worthless matter passing into the furnace during the discharge of the conveyor. The receiving bin will contain 200 cubic yards, and is intended to be used only for reserved refuse to obtain heat and steam power before the conveyor is put into operation.

The "Morse-Boulger" Destructor (see Fig. 46) will be seen to differ essentially from other American destructors already described. The cell is built of the most refractory firebrick to be had, and is specially moulded and shaped to fit each particular place, no iron being employed where flame is in direct contact. Outside, the cell is bound together by cast iron buck stays, connected by strong tie rods, and heavy longitudinal thrust bars of steel angle iron, to which the doors controlling all openings are securely bolted.

A secondary firebox is provided for the cremation of any escaping noxious gases, and careful arrangements are made for the trapping of dust, so that the gases may be delivered to the boiler as free from dust as possible. The chimney is of steel, self-supporting, one hundred and twenty-five feet in height, lined with firebrick, and securely bolted to a base 14 feet in height. Between the cell and the chimney a steam boiler is set, so controlled by dampers that it can readily be fired either by the destructor gases or by hand with coal in the ordinary way. The steam generated is used for driving the engine for conveyor, and also for driving a Westinghouse engine and dynamo coupled, for providing electric light in the works, as well as a system of steam-heating coils.

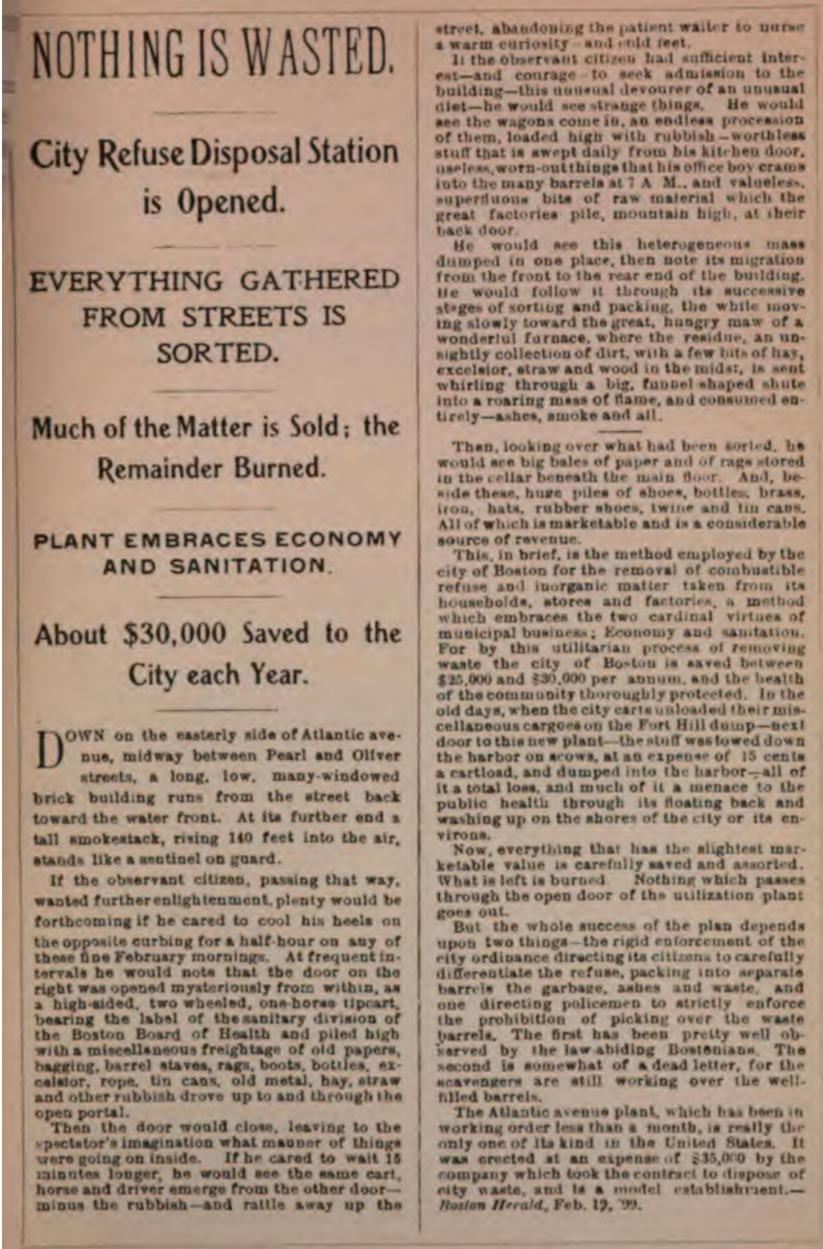
The accompanying reduced facsimile page from the *Boston Herald* in reference to this plant will be of interest.

Generally speaking, this type of destructor may be said to more closely approximate to our British practice than any other American destructor. It is of interest to notice that the "Morse-Boulger" has been adopted at New York, Jersey City, Chicago, Washington, Brooklyn, and San Salvador also. In dealing with the various American destructors I have just chosen representative furnaces of particular types; there are a number of other cremators and incinerators, a few of which I will mention—the Lester furnace at Atlanta, Georgia; the Smeed furnace at Toledo, Ohio; the Davis furnace at Regla, near Havana, etc., etc.

It is not my business in this work to make comparisons between the various systems dealt with, but a few general observations will not be out of place. Firstly, it will be noticed that the employment of a secondary fuel-fired furnace or fume cremator is general, although some of the makers claim that no fuel other than refuse is used, and that it is self-destroying.

It is obvious that a fume cremator, or a scent burner, cannot be fired with refuse; some better fuel of greater calorific value must be employed, as has been demonstrated in this country years ago, and in some installations even down to this day coke is used. Modern destructor practice in this country shows that a fume cremator is quite unnecessary; modern destructor practice in America has not yet generally established that fact.

Again, although some of the American destructors are disposing of large quantities of refuse per cell per day, yet generally



NOTHING IS WASTED.

City Refuse Disposal Station is Opened.

EVERYTHING GATHERED FROM STREETS IS SORTED.

Much of the Matter is Sold; the Remainder Burned.

PLANT EMBRACES ECONOMY AND SANITATION.

About $30,000 Saved to the City each Year.

DOWN on the easterly side of Atlantic avenue, midway between Pearl and Oliver streets, a long, low, many-windowed brick building runs from the street back toward the water front. At its further end a tall smokestack, rising 140 feet into the air, stands like a sentinel on guard.

If the observant citizen, passing that way, wanted further enlightenment, plenty would be forthcoming if he cared to cool his heels on the opposite curbing for a half-hour on any of these fine February mornings. At frequent intervals he would note that the door on the right was opened mysteriously from within, as a high-sided, two wheeled, one-horse tipcart, bearing the label of the sanitary division of the Boston Board of Health and piled high with a miscellaneous freightage of old papers, bagging, barrel staves, rags, boots, bottles, excelsior, rope, tin cans, old metal, hay, straw and other rubbish drove up to and through the open portal.

Then the door would close, leaving to the spectator's imagination what manner of things were going on inside. If he cared to wait 15 minutes longer, he would see the same cart, horse and driver emerge from the other door—minus the rubbish—and rattle away up the street, abandoning the patient waiter to nurse a warm curiosity—and cold feet.

If the observant citizen had sufficient interest—and courage—to seek admission to the building—this unusual devourer of an unusual diet—he would see strange things. He would see the wagons come in, an endless procession of them, loaded high with rubbish—worthless stuff that is swept daily from his kitchen door, useless, worn-out things that his office boy crams into the many barrels at 7 A. M., and valueless, superfluous bits of raw material which the great factories pile, mountain high, at their back door.

He would see this heterogeneous mass dumped in one place, then note its migration from the front to the rear end of the building. He would follow it through its successive stages of sorting and packing, the while moving slowly toward the great, hungry maw of a wonderful furnace, where the residue, an unsightly collection of dirt, with a few bits of hay, excelsior, straw and wood in the midst, is sent whirling through a big, funnel shaped shute into a roaring mass of flame, and consumed entirely—ashes, smoke and all.

Then, looking over what had been sorted, he would see big bales of paper and of rags stored in the cellar beneath the main floor. And, beside these, huge piles of shoes, bottles, brass, iron, hats, rubber shoes, twine and tin cans. All of which is marketable and is a considerable source of revenue.

This, in brief, is the method employed by the city of Boston for the removal of combustible refuse and inorganic matter taken from its households, stores and factories, a method which embraces the two cardinal virtues of municipal business; Economy and sanitation. For by this utilitarian process of removing waste the city of Boston is saved between $25,000 and $30,000 per annum, and the health of the community thoroughly protected. In the old days, when the city carts unloaded their miscellaneous cargoes on the Fort Hill dump—next door to this new plant—the stuff was towed down the harbor on scows, at an expense of 15 cents a cartload, and dumped into the harbor—all of it a total loss, and much of it a menace to the public health through its floating back and washing up on the shores of the city or its environs.

Now, everything that has the slightest marketable value is carefully saved and assorted. What is left is burned. Nothing which passes through the open door of the utilization plant goes out.

But the whole success of the plan depends upon two things—the rigid enforcement of the city ordinance directing its citizens to carefully differentiate the refuse, packing into separate barrels the garbage, ashes and waste, and one directing policemen to strictly enforce the prohibition of picking over the waste barrels. The first has been pretty well observed by the law abiding Bostonians. The second is somewhat of a dead letter, for the scavengers are still working over the well-filled barrels.

The Atlantic avenue plant, which has been in working order less than a month, is really the only one of its kind in the United States. It was erected at an expense of $35,000 by the company which took the contract to dispose of city waste, and is a model establishment.—*Boston Herald*, Feb. 19, '99.

FAC-SIMILE FROM "BOSTON HERALD," FEBRUARY 19TH, 1899. RE-OPENING OF THE "MORSE-BOULGER" DESTRUCTOR AT BOSTON, MASS.

speaking they are comparatively getting little or nothing out of it in the way of power; such complete and exhaustive tests as are made in this country seem to be unknown in America. The information available is usually very vague, and so one is not able to fairly compare our practice with that of the other side. However, sufficient can be seen to satisfy destructor engineers in Britain, and I trust in America also, that we are considerably in advance of the best American practice in refuse destruction, while the American engineer will be able to see by what means the high efficiency now obtained in this country has been reached.

REDUCTION OR UTILISATION PROCESSES.

Reduction or utilisation plants have failed for many reasons, a few of which I will enumerate. In the first place, garbage is the only portion of a city's waste with which it is possible for such a plant to deal. Therefore the adoption of such a system involves, in the first place, the sorting of the refuse; this must either be done by the citizen, or it has to be done at the works, where the decaying organic matter gives off such offensive smells that the premises and the process soon proclaim themselves to be an intolerable nuisance.

Again, this system necessitates the employment of much costly and complicated machinery.[1] This must be put down in duplicate in case of breakdown; thus a very heavy capital expenditure is incurred. Further, there is the danger of a strike in the event of an epidemic. It will thus be seen that such a method cannot seriously commend itself to thinking sanitarians; it is weak all round, and unsatisfactory.

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[1] Reduction processes require a large outlay for machinery and plant. It has been stated that the St. Louis establishment cost 275,000 dollars, including the land. The following is a list of the machinery:—Twelve 125-h.p. horizontal tubular boilers; 1.250-h.p. Corliss engine; 1.36-h.p. engine and one 250 — 3 c.p. light dynamo; 1.60-h.p. fan engine; 1.75-h.p. engine for bone mill and screens; three duplex pumps, capacity 525,000 gallons; two small pumps, capacity 225,000 gallons; five No. 8 Garden City fans; sixteen Eureka driers; four Preston digesters 8½ feet diameter by 14 feet high; eight garbage receiving tanks; one Otis engine and elevator; mill screens, conveyors, elevators, rectifying tanks, oil pumps, &c. With regard to the capacity of the plant detailed above, the daily average for the month of August, 1894, was 226 tons per day.—From *Brooklyn Health Department Report for 1896.*

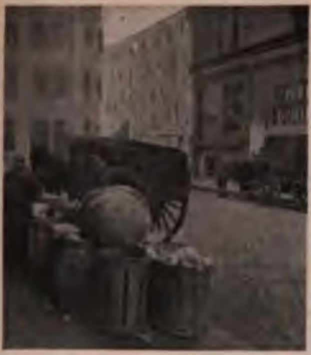

FIG. 50.—SCAVENGERS AND WASTE BARRELS, BOSTON, U.S.A.

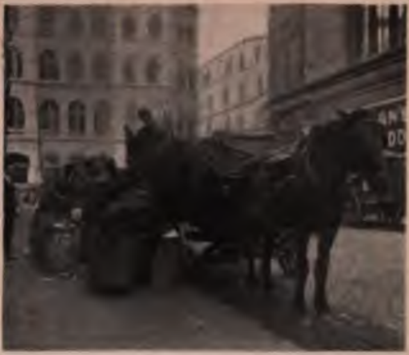

FIG. 51.—COLLECTING COMBUSTIBLE WASTE IN BOSTON—SHOWING CITY TEAM.

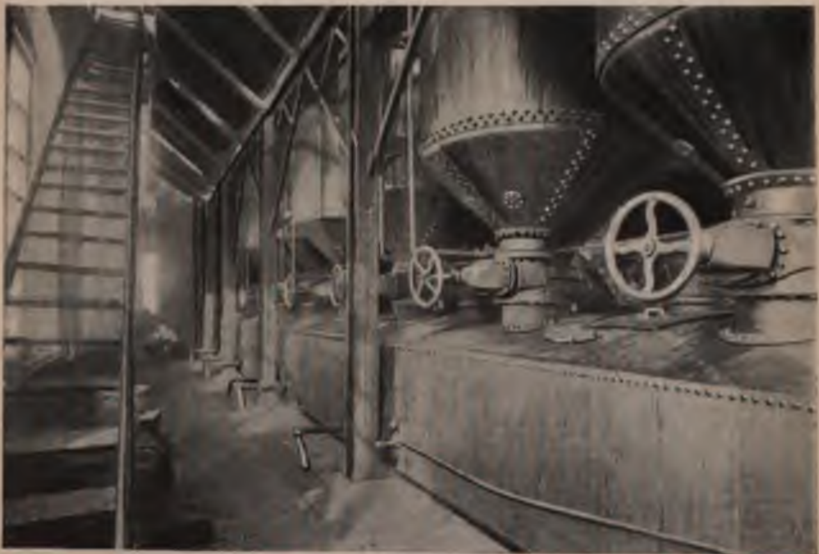

FIG. 52.—COOKING TANKS—ARNOLD PROCESS REDUCTION WORKS, PHILADELPHIA.

(To face page 236.)

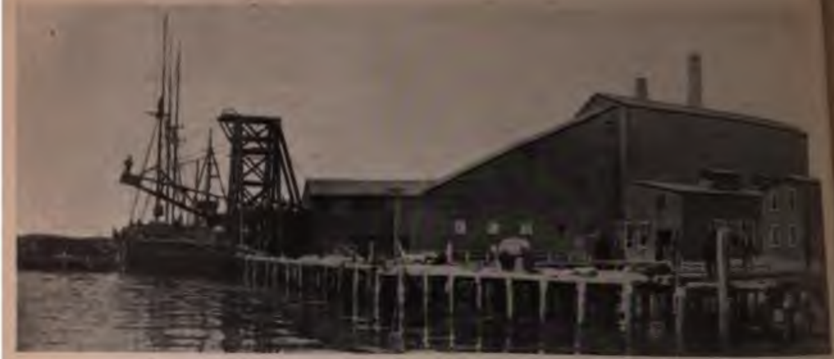

FIG. 53.—REDUCTION WORKS AT BARREN ISLAND, NEW YORK.

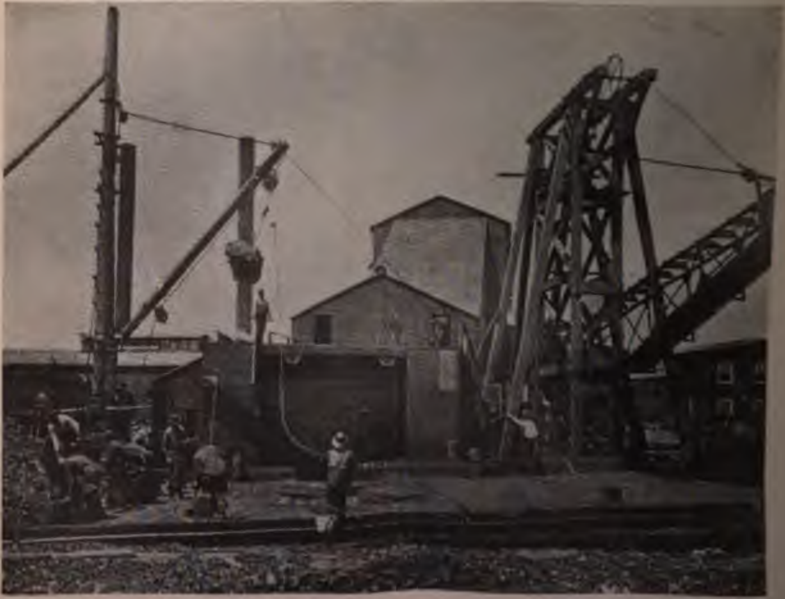

FIG. 54.—HOISTING GARBAGE FROM SCOWS AT REDUCTION WORKS, BARREN ISLAND, NEW YORK.

Mr. A. H. Andrews, of Atlanta, Georgia, who has given this matter a deal of study, reports as follows regarding reduction processes :—

"No one would be so foolish as to attempt a reduction plant in New Orleans to-day, while an epidemic prevails in that city. I doubt if the large and costly reduction plant lying idle there could turn a wheel while yellow fever lasts.

"Less than twenty reduction plants have been established to dispose of garbage in American cities, and not one-half of them are in operation to-day. All have been financial failures, all have received large bonuses from the cities, yet the capital stock of the different reduction companies has no known value. Boston, Washington, New Orleans, and other great cities have tried the experiment and want no more of it."

According to Mr. C. Herschel Koyl., of New York City, garbage from kitchens and markets consists of about 7 per cent. rubbish, cans, bottles, rags, etc., 70 per cent. water, 3 per cent. grease, and 20 per cent. of a mixture of animal and vegetable dry matter, which is generally sold without any further separation, to manufacturers, who make it up into fertiliser.

To cook the raw garbage and separate it into these four substances—rubbish, water, grease, and fertiliser material, is the object of all garbage reduction, or utilisation systems. The rubbish has scarcely any value to repay its separation, and the water has none ; thus to get rid of these two substances, the one averaging 70 per cent., the other 7 per cent., is the expensive part of any reduction process. The grease, when reasonably free from other matter, is easily sold for three cents. per pound, and the dry matter generally known as "tankage," from having been cooked in large iron tanks, sells for about 6 dollars per ton.

As with refuse, the percentages of composition vary from city to city, and in any city varies with the season ; the prices to be obtained for grease and "tankage" varies with the quality of each, but the figures given may be taken as a fair average. The main difference between reduction systems are due to variation in methods of separating the grease and water from the solids ; minor differences arise from greater or less refinement of treating grease and "tankage," to increase their selling value, and from greater and less success in preventing the escape of odours during the cooking and drying.

The special machinery used in some or all of the processes consists of cooking tanks, sometimes known as digesters or extractors, presses, dryers, fume destroyers, grease extracting tanks, naphtha tanks, naphtha condensors, screening apparatus and disintegrators or mills for grinding the coarse dry material. Cooking tanks usually take a charge of six tons of garbage at a time. In some cases live steam only is used to ensure more complete deodorisation.

The water is extracted by the application of pressure. This method is cheaper than evaporation; it is also useful as being a cheap way of recovering a small proportion of the grease. Where the residue is intended to be used as a fertiliser, a quantity of sulphuric acid is used during the cooking process; also before drying, a portion of phosphoric acid is added.

It will be at once apparent, from the foregoing and the accompanying illustration (Fig. 52), that the process is complicated, lengthy, and costly, and even to the uninitiated it will be seen that for simplicity and finality it does not for one moment compare with destruction by fire. Again, it should not be lost sight of that garbage only represents a proportion, sometimes a very small proportion, of the bye products of existence, and that the system is not intended to deal with anything but garbage.

The principal reduction plants in America have been installed at St. Louis and Philadelphia. At the former place the Arnold process is in use, and at the latter the Merz process. According to Mr. L. R. Ellert, of San Francisco, the cost per ton for reduction at both places is 1·80 dollars as a minimum. Further, Mr. Ellert reports that "The Merz Reduction Works at Milwaukee, Wisconsin, were abandoned, and an experimental plant at Chicago proved a failure. The works erected to reduce by the Simonin process at New Orleans, Cincinnati, and Paterson, New Jersey, were failures. In addition to this, every reduction process leaves a residuum, which, if it is intended to dispose of the garbage in a sanitary manner, must itself be disposed of by cremation."

It will thus be evident that, even if a reduction process is adopted in any city, there is still room and urgent need for a destructor. But why put up the former at all, when the latter, if worthy of its name at all, can finally dispose of all garbage with ease and without nuisance? Unfortunately, nuisance would seem to be inseparable from reduction, and complaints have been many and frequent, probably far more serious than the outcry in this country in the early days of refuse destruction.

[1]ANALYSIS OF ASHES FROM GARBAGE.

	Per cent.
Silica and matter insoluble in Hc. ...	16·986
Calcium carbonate	8·007
Magnesium phosphate	3·010
Calcium phosphate	66·855
Calcium sulphate	1·269
Free carbon	0·072
Sodium chloride...	2·187
Calcium fluoride...	1·170
Ferric oxide	·619
Potassium	Trace.
	100·75 per cent.

[2]According to the Brooklyn Health Department report, in which a number of reduction processes and also cremators are carefully considered, the following table includes the representative American reduction systems classed according to process employed :—

(1) Merz. Solvent method, using naphtha.
(2) Simonin. Solvent method, using benzine.
(3) Consolidated American Reduction Company. Moist melting.
(4) Holthaus. Steam melting.
(5) Arnold. Steam melting.
(6) Hogel. Steam melting.

It will be seen from the following table that, although all the above systems have been tried, some in large and important cities, yet the remarks very often would tend to make a sanitary authority pause ; at any rate, such would be the case in this country.

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[1] By Professor R. Ellsworth Call, of Drake University, Des Moines, Iowa.
[2] See the Brooklyn Health Department Report for 1896.

SIMONIN PROCESS.

City.	Population.	Remarks.
New Orleans, Louisiana	275,000	closed
Cincinnati, Ohio	406,000	closed
Paterson, New Jersey...		closed
Providence, Rhode Island	150,000	closed

CONSOLIDATED AMERICAN REDUCTION CO.

City.	Population.	Remarks.
Pittsburgh, Pennsylvania	285,000	running
Philadelphia	1,500,000	experimental

HOLTHAUS PROCESS.

City.	Population.	Remarks.
Brooklyn, New York	2 new wards	abandoned
Bridgeport, Connecticut	65,000	in the hands of the receiver

MERZ PROCESS.

City.	Population.	Remarks.
Buffalo, New York	375,000	running
Detroit, Michigan	360,000	,,
St. Louis, Missouri	650,000	,,
Milwaukee, Wisconsin	260,000	closed
Chicago	1,750,000	experimental

NEW YORK GARBAGE.—ANALYSIS.

	Per cent.
Moisture	70
Grease (recoverable)	3
Available (solids)	25
Non-combustible	2

	Tons.	Per cent
Department of Street Cleaning. Collection	124,200	7·3
Permit	15,000	·9
In ashes	31,100	1·8
	170,300	10

AVERAGE ANALYSIS.

	Per cent.
Water	65·90
Total Solids	34·10
Nitrogen	0·86
Fat	7·07
Phos. acid	0·07
Potash (K 2o)	0·03
Mineral matter	8·48

ARNOLD PROCESS.

City.	Population.	Remarks.
Boston, Massachusetts	501,000	Closed
Washington, D. C.	280,000	Closed
Philadelphia, Pennsylvania	Three districts out of five	Running
New York, New York	1,962,000	To close at end of present contract in one year.

HOGEL PROCESS.

This was adopted at Rochester, New York, and has been abandoned.

Just to briefly allude to the process employed at Barren Island, New York, which, like many another, seems destined to be closed shortly. Here New York garbage is dealt with, the amount being only 8½ per cent. of the total refuse of New York. The company who have the contract tow the garbage in scows to Barren Island, being paid by the City 90,000 dollars a year, or say 60 cents. per ton, but I understand this is cheap as compared with some American cities, St. Louis, for example, paying a dollar and 80 cents. by the ton.

Apart from the cost, it must not be forgotten that only a portion, practically a small portion, of the civic waste is being dealt with, and it would be possible to burn that portion easily along with the combustible portion of the refuse, without any nuisance.

CHAPTER XVIII.

REFUSE DISPOSAL IN EUROPE.

ALTHOUGH, generally speaking, we have moved slowly in this country in the sanitary disposition of our refuse, yet it may be fairly said that we have done very much better than any of the European countries. There are a few notable exceptions, but, as a whole, our Continental friends, with our American cousins, have a great deal to learn yet. We will begin with the city of Paris.

PARIS.

Here all garbage and household refuse is collected every morning between the hours of 6 and 6.30 a.m. in the summer months, and in the winter months at a later hour. At one time the garbage was placed on the kerb, and much annoyance was caused by the rag pickers scattering the material about as they looked through same. Accidents also occurred through broken bottles being thrown in the roadway. This primitive arrangement was doomed. It was decided that the landlord, *i.e.*, the property owner, must provide each tenant with a receptacle into which the refuse must be placed, instead of having it in a heap on the pavement.

But still the Parisian rag pickers exist; in fact, they are quite an institution, enjoying almost the special protection of the Government. They delve into the refuse receptacles as they stand on the kerb, and even into the wagons as they are being loaded. There is no need for them to go a long way to the tips, as is the custom here, when they can pick and choose at the source of supply.

It is said that the annual cost to the city of Paris for the removal of refuse is over 2,000,000 francs yearly. It has been tried from time to time to utilise the refuse, but apparently little, if any, headway whatever has been made. At one time there was a scheme to convert the mussel and oyster shells into manure, but this idea was soon abandoned, and they are now tipped into disused quarries outside the city. To give our French neighbours their due, they have, to some extent, considered the adoption of destructors, but it was found that the total capital expenditure would amount to 6,000,000 francs.

I understand, however, that it was not the financial phase of the matter altogether which throttled the scheme: they were told that while the refuse was collected in two hours in the morning, it was essential, for the economical working of a destructor, that the work should be continuous throughout the 24 hours. This seems to have been the means of setting the authorities against the installation of destructors. Surely this difficulty might have easily been surmounted by carefully rearranging the collection of the refuse.

It will be obvious that refuse could not be collected in the show thoroughfares of the city during the busy part of the day, but in other parts of the city it would seem that the collection might have been so arranged that a continuous supply of refuse might be ensured, to say nothing of storage, for a few hours, if necessary. After many enquiries it was at length decided to make some experiments, and in 1896 a trial was made of an experimental destructor at the Javal Municipal Works.

The type of cell used was similar to a Fryer, but with slight modifications in detail. The width of the cell was increased to 2 m. as compared with Fryer's standard, 1·52 m. The grate, which was of the ordinary fixed type of bar, was inclined at an angle of 23°. The grate area was 3 sq. m.=32·2 square feet. The drying hearth was set higher at the top end than with the Fryer, and had an area of 3·60 sq. m.

A steam boiler with 20 sq. m. of heating surface was set in connection with the cell, but it was also arranged for the gases to travel direct to chimney through a bye-pass flue, if so desired. Two Körting Steam Jet Blowers were used to provide a forced draught under the grate.

Experiments extended over some eight months, but the results obtained were not altogether satisfactory; it was found impossible to reach a sufficiently high temperature. This led to certain modifications, principally in the provision of recuperation to provide hot air for combustion.

The results obtained, both with the original and the improved furnace, were not at all startling, and the conclusion arrived at was that, although unlike some Continental refuse, Parisian refuse contained sufficient combustible to be self-consuming, yet it was practically worthless for anything beyond that.

VIENNA.

Here there is no refuse destructor, although in this instance the collection of refuse is continuous throughout the day. Large cumbersome covered wagons perambulate the streets to collect the refuse; a warning bell is rung, and the refuse is put out on the kerb in boxes, baskets, and receptacles of every kind, just in time for the wagon.

The refuse, together with the street sweepings, is then hauled out into the country some four or five miles. When the vans arrive, the Austrian edition of the Parisian rag picker sets to work sorting the mass for any hidden treasure. I should say that the Vienna rag picker is not in business for himself, but is employed by the contractor who collects the refuse.

Men, women and children are employed at this work, the duty being to pick out everything of any value whatever; every Saturday they are allowed to take home with them what wood or fuel they have found that day, and it is but human nature that more is found on this than on the other five days. All unsaleable refuse is utilised for filling up depressions left by the old course of the Danube.

BUDA PEST.

The Hungarian capital is in many respects a model community as regards the disposal of refuse, and this is the more striking as it is being done by a contractor. All the refuse and night soil is taken to the "Kehrichtring," or rubbish boulevard at Kleinpest, about six miles out of the city; it is all conveyed by rail. Here the only population consists of some two hundred and fifty men, women and children, who are employed in the works.

These works were started some 33 years ago by Mr. Ignatius Fischer, who was at that time the contractor, and slowly but surely the works have developed into a most complete factory, embracing the most careful and systematic separation of all the waste; also the manufacture of fertilisers, ammonia and other marketable products. Most of the handling of the refuse is done by machinery, the whole of which is enclosed in a four- building; the unsaleable portion of the refuse is used as fu provide the necessary steam power.

On the picking tables, nothing of the slightest selling valu allowed to pass; the authorities here, after years of careful st are able to turn almost everything to some useful account.

BERLIN.

Until quite recently, private contractors removed all the refu in this city; there were some two hundred contractors, larg and small.

They collected all refuse from the interior of houses; no pails or ash barrels are permitted outside on the pavement, as in Paris, Vienna, and other places.

Both the contractors who removed domestic and trade refuse, and also those who removed street sweepings, had to provide their own tips for same. Some of the refuse was sold for manure, some was used for filling up low-lying land, the remainder being deposited on tips.

Berlin, like most other large cities, is growing at a rapid rate, consequently the refuse had to be tipped further and further out at an increasing expense.

"The problem of destroying refuse by cremation has been considered for a number of years, because it was usually assumed that if these matters could be burned, all sanitary danger contained in same would be avoided.

"It was also thought that if cremation could be obtained in special cremators, which would not require a special degree of heat, it would be the cheapest method of final disposition.

"The opinions on this subject differ greatly, but certain results reported to have been obtained in some towns in England induced the Common Council to take the question into serious consideration."[1]

After consideration, it was decided that an experimental plant be tried, and Messrs. Horsfall erected a 3-cell destructor, and Messrs. Goddard, Massey and Warner 2 cells on the site of the old Water Works in Berlin.

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[1] Experiments made according to English methods. (See report of the City of Berlin for 1894 and 1895.)

The experiment does not appear to have been altogether satisfactory, and, up to the present, nothing further has been done with either of these types. During the winter months the cells required a proportion of added fuel, which, of course, was not satisfactory at that time, although since then, it will be seen, supplementary fuel has been used, and is still.

Closed stoves are almost universally in use in Berlin, and briquettes are largely used as fuel ; thus the residue is composed of a quantity of very fine dust. This was not combustible, and as a very large percentage was usually found, it was very awkward to deal with, giving considerable trouble in choking the air spaces of the fire bars.

The varying nature of refuse on the Continent must inevitably give trouble, and necessitates, in the first instance, small experimental plants. There is no doubt that with the experience gained a much more satisfactory plant might now be erected in Berlin.

The authorities here, eager for sanitary reform, were mainly encouraged to experiment with the Horsfall and Warner cells, owing to the success of the former at Hamburg, but although skilled firemen were sent through from Leeds, and German firemen were sent to Leeds to acquire a knowledge of the work over here, yet the success at Berlin fell short of that at Hamburg.

It must, however, be pointed out in fairness to all parties that the refuse of Berlin is exceedingly difficult to deal with. The incombustible ash constitutes 37 per cent. by weight and 47 per cent. of the bulk of the winter refuse, while the combustion of the coarse refuse yields 36 per cent. of slag and 14 per cent. of ash.

A new type of destructor has recently been tried in this city. The furnace is about 18 ft. in height, and the temperature is said to be 2900° Fahr. The refuse is shot into large revolving drums and dried by means of hot air ; from these it falls into the furnace, the hot gases are used for generating steam power, and the hot residue drops into a water tank.

Fifty tons of refuse per furnace are consumed per 24 hours, the estimated total quantity of refuse in Berlin being over 1,300 tons per 24 hours. Since the trials with the one furnace, 20 more have been erected.

The very high temperature is accounted for by the use of coal dust as a secondary fuel for burning the refuse. This is used constantly. It would be interesting to know the cost per ton of refuse destroyed, seeing that a supplementary fuel is used in such quantity. I understand that this is quite prohibitive, however.

HAMBURG.

Much attention has been devoted here to the question of refuse disposal. The following particulars are taken from a report by Herr Andreas F. Meyer, City Engineer :—

"The refuse is composed of domestic refuse, town refuse, dock refuse, and street sweepings. The population is estimated to be 300,000 persons, and for the destruction of their refuse 36 cells, each having 27½ square feet of grate surface, were installed. The works are situated in the centre of the city, and in case of epidemic all suspicious matter would, of course, be cremated here also. For preliminary trials four Horsfall cells and two Warner and Whiley cells were erected. The latter were afterwards altered to Horsfall's system. After a trial of six months the Horsfall Company were instructed to erect 30 additional cells ; about 6½ tons per cell per 24 hours is consumed ; to deal with each three cells one stoker is provided, and three eight hours shifts are worked. The forced draught is provided by two centrifugal blowers, each driven by a 16 B.H.P. electric motor. Two boilers are provided to utilise the heated gases for steam raising. The steam pressure in the boilers is six atmospheres. The steam is used to drive two 40 H.P. dynamos, which drive the electric cranes, blowers and clinker crusher, also generate current for 14 Arc lamps at eight ampères and 62 25 C.P. incandescent lamps for lighting the works."

Mr. Meyer says that the excess of heat now going to waste would give 100 H.P. per hour besides. Thus we have from 36 cells, each burning approximately 6½ tons per cell per 24 hours, a total of 180 I.H.P. per hour, or 5 I.H.P. per cell per hour.

COLOGNE.

A deputation from the city of Cologne visited a number of *installations* throughout England last year.

WIESBADEN, TRIESTE, AND MUNICH.

Here the Municipality are about to invite tenders for a Destructor.

GENEVA.

Messrs. Horsfall have a 12-cell plant in hand for the Municipality here. This was decided upon after a visit of inspection to England, in 1898, by M. Ami Wagnon, President du Conseil Administratié Délégué à la Voirie.

BRUSSELS.

In 1887 a deputation from Brussels visited this country to look into the question of sanitary refuse disposal. In their report is indicated their unanimity as to cremation being the most hygienic and only proper treatment of refuse, also that, with well constructed and properly regulated furnaces, no nuisance is caused.

As the result of their report in 1891, the Administration of Brussels authorised the construction of a trial furnace on the Voirie Quay at Molenbeek St. Jean. The object of the installation was to show that the refuse could be destroyed without the addition of any supplementary fuel, and further, that it could be done without creating a nuisance.

Although the results of the experiments were quite satisfactory, yet nothing further appears to have been done since.

NAPLES.

Although destructors have not yet been erected in Naples, yet the matter has been receiving a deal of consideration. About 18 months ago a number of papers on sewage and refuse disposal were read before the Reale Institute d'Incorragiomento di Napoli.

To Professor Paolo Boubee is due the honour of awakening some interest in sanitary reform. He seems to rather favour a reduction process, such as the Arnold le Blanc system. The refuse of the Neapolitan streets is said to be too heavy in moisture and to contain too little carboniferous matter to be satisfactorily destroyed without the addition of coal.

At present the refuse and street sweepings are carted some distance outside the city and deposited on tips, where the accumulations are largely used as manure, but the effluvia from so large a mass of putrefying matter has become prej to health.

TURIN.

The question of disposing of the refuse in destructors has under consideration here within the past year.

ROME.

Here, in this ancient city, the advisability of erecting destructor is now under consideration.

ROTTERDAM.

A deputation from the Municipality of this city have been o a tour of inspection in England this year, with a view to settling upon the most suitable type of destructor to meet the requirements of their city, and I understand that the Municipality are just about to invite tenders for the erection of a destructor.

COPENHAGEN.

From this city also a deputation has been in England on a tour of inspection. I am given to understand that an early decision will be made, and that an English destructor will be adopted.

LISBON, PORTUGAL.

Some months ago an accredited agent of the Government was in this country inspecting destructors, with a view to recommending their adoption in that city. Up to the present nothing has been done, but the question is likely to be revived again shortly.

GIBRALTAR.

Here a 2-cell Fryer Destructor is in use, 7½ tons are dealt with per 24 hours, the refuse including night soil and stable manure.

CHAPTER XIX.

SOUTH AFRICA.

CAPE TOWN.—Here the question of erecting a destructor has been under consideration for some two years past, but nothing definite has yet been decided; the question has recently been revived.

DURBAN.—Messrs. Goddard, Massey and Warner have erected a 4-cell installation here.

PORT ELIZABETH.—The refuse is tipped here, as will be seen from the accompanying illustration. (See Fig. 55.)

EAST LONDON.—Messrs. Goddard, Massey and Warner now have a 4-cell destructor in hand for this town.

JOHANNESBURG.—It is now about four years ago since the authorities here first seriously faced the question of disposing of the refuse in a sanitary manner. In September and October, 1896, tenders were invited for the erection of refuse destructors, and some twenty offers were received. The merits of each offer were thoroughly gone into, but only four were selected as being most suitable for the requirements of the town. After further consideration, it was decided not to accept any of the tenders, but to wait until a suitable site could be obtained, so that each competing firm could then go into the question further on a firm basis.

Since then Mr. Arburrow has visited a number of installations in England, but up to the present nothing has been done, apparently because of the great difficulty in obtaining a suitable site. A site was selected in a very convenient place 3½ acres in extent, but the price asked was exorbitant, being £25,000, with an annual rental as well of £18. Some few public meetings have been held with a view of getting the public feeling as to the purchase of this site, but they have been of a most noisy character, if not actually riotous, and there would appear to be a carefully organised opposition to the purchase; so the deadlock continues.

BULUWAYO (RHODESIA).—Here the municipality have decided to make a trial of a method of getting rid of the refuse in the following manner. A number of parallel trenches, each about half a mile long, are to be dug on the common; the refuse will then be deposited therein and covered over. Timber trees of various kinds will then be planted, the preference being given to the hardiest and most useful varieties; in this way it is claimed that the enormous fertilising capabilities of the town's refuse will be made use of both for the material as well as the ornamental advantage of the place.

This same method has been in vogue at King Williamstown for some time past, it is said with very satisfactory results so far as they go.

LAGOS (WEST AFRICA).—A few months ago the authorities here were making some inquiries with a view to adopting a destructor, and the matter is still under consideration.

CHAPTER XX.

INDIA.

CALCUTTA.—A 4-cell Horsfall Destructor was erected here in 1891.

MADRAS.—Messrs. Goddard, Massey and Warner erected a 12-cell destructor here some years since.

KARACHI.—At the present time Messrs. Goddard, Massey and Warner have two of their Warner "Perfectus" cells in hand for this place.

BOMBAY.—According to the last census, this city has a population of 821,764. Every day some 1,766 cartloads of refuse and town sweepings have to be disposed of, the weight being approximately 883 tons. Of this quantity about 123 cartloads could be usefully employed in reclaiming some of the low-lying land on the outskirts of the city owned by the Municipality.

Out of each day's collection an average of about 477 cartloads is said to be incombustible, leaving a balance of something like 1,166 cartloads of combustible material to be dealt with as well.

Mr. M. C. Murzban, C.I.E., M.Inst.C.E., F.R.I.B.A., Executive Engineer to the Corporation, has given the question of refuse disposal considerable attention. A number of crude incinerators were tried before Mr. Murzban took the matter in hand, but without any success.

Finally it was arranged for Messrs. Garlick and Christenson, of Bombay, to erect an experimentary destructor on their patented principle. The experiments showed :—

a. That each furnace was capable of consuming on an average 31 cartloads or 15½ tons of wet refuse, and 44 cartloads, or 22 tons, of dry refuse per day of 24 hours.

b. That on an average about nine cartloads of residue were produced by the incineration of 100 cartloads of (*kutchra*) refuse.

c. That the monthly expense of working the three furnaces amounted to Rs.700 ; and

d. That on this basis the average working expenses for consuming one cartload of dry and one of wet ***kutchra*** would be 2·83 and 4·01 annas respectively.

The refuse of Bombay (generally known in that city by the name of *kutchra*) differs essentially, like all tropical refuse, from the refuse in this country, containing considerable quantities of damp straw and green vegetable refuse, and practically no cinder or refuse with any calorific value.

The experiments with Messrs. Garlick and Christenson's incinerator quite satisfied the authorities that if incineration was decided upon this type would satisfactorily meet the case, and it was so far settled that, if disposal by fire was deemed necessary or advisable, one or more of these incinerators should be erected in each of the seven wards of the city.

After much consideration, however, it was decided not to destroy the refuse in the city for two reasons. Firstly, the authorities were afraid of the smoke nuisance; and, secondly, it was thought the odours from the collected garbage would give rise to endless complaint.

The alternative suggestion was to erect incinerators at "Mahalaxmi Flats," which place had been used for tipping refuse, but this did not meet with general approval, because of the quantity of residue and incombustible likely to accumulate there.

It was decided ultimately to again tip the refuse, this time at Coorla and Devnur, on the G.I.P. Railway, there to reclaim some low-lying land, of which there is sufficient to take the Bombay refuse for about twenty-three years.

The estimated annual cost of this transportation and tipping scheme, including sinking fund and interest on the initial outlay, is Rs.2,28,586. This is cheap if compared with the cost of incinerators here given, but let it not be forgotten that the method adopted is not one of final disposition, and in the light of our modern British practice such a decision is very extraordinary.

INITIAL COST OF INCINERATION.

The scheme was estimated at Rs.7,80,940, and its annual working expenses, including the transportation of non-combustible to Chimbur, together with sinking fund and interest on original outlay, was put down at Rs.3,59,269, as here shown. The number of cartloads of *kutchra* (excluding the quantity hich could be disposed of in reclaiming some of the lowing land in the outlying parts of the city, and the non-comustible refuse) is 1,166. As a cell of the Garlick type disposes f 31 cartloads in the monsoon, the total number of cells equired would be 38, the cost of which, including land and chimneys, would be Rs.6,63,100, as here detailed :—

38 Furnaces at Rs.10,000 each	Rs. 3,80,000
3 Chimneys at Rs.32,000 each... ...	Rs. 96,000
Total	Rs. 4,76,000
Add 10 per cent. for contingencies, establishments, &c.	47,600
Total	Rs. 5,23,600
Value of 33,000 square yards of land at Rs.2—8 per square yard	82,500
Royalty 38 × 1,500 payable to the patentees...	57,000
Total	Rs. 6,63,100

It was thought that a reserve of at least 20 per cent. of furnaces over and above the number actually required should be provided. This raised the actual estimated cost of incinerators to Rs.7,80,940.

The total sinking fund and interest on the initial outlay would be Rs.56,510, as detailed below :—

Annual sinking fund and interest required to recoup in 15 years (estimated life of furnaces, &c.), at 4 per cent. on the initial outlay of Rs.5,06,000 on the construction of 46 furnaces	Rs. 45,512
Interest at 4 per cent. on the balance of the initial outlay, viz., (Rs. 7,80,940—5,06,000), the cost of the chimneys, land, and the amount of royalty, &c.=Rs.2,74,940, is	Rs. 10,998
Total	Rs. 56,510

ANNUAL EXPENSE.—THE TOTAL COST OF WORKING WOULD BE RS. [illegible] INCLUDING THE CARTAGE OF THE NON-COMBUSTIBLE REFUSE TO CHIMBUR AS DETAILED BELOW.

Items.	Working Expenses.		Remarks.
	During Wet Months.	During Dry Months.	
Coolies	38 × 9 = 342 @ Rs. 10 each = Rs. 3,420	27×9=243 @ Rs. 10=Rs. 2,430	After a few years the residue from the incinerator refuse would also have to be carted away to a distance, the extra cost of which is not included in this estimate.
Mucadams ...	5×3 = 15 @ Rs. 15 = Rs. 225	... ... Rs. 225	
Third - class Engineer	5×3 = 15 @ Rs. 40 = Rs. 600	... ... Rs. 600	
Coal	38×4=152 @ Rs. 18= Rs. 2,736	27×4=108 @ Rs. 18=Rs. 1,944	
Oil, waste, etc. ...	... ... Rs. 200	... ... Rs. 200	
Repairs	... ... Rs. 436	... ... Rs. 436	
Monthly expenses	... ... Rs. 7,617	... ... Rs. 5,835	
Four wet months	... ... × 4	... ... Dry months × 8	
	Rs. 30,468	Rs. 46,680	

Total Rs. 77,148

Annual cost of carting away 1,066 cartloads of ashes and depositing same within city limits, at 3 annas per cartload ... ... = Rs. 7,980

Annual cost of carting away to Chimbur daily the 477 cartloads of non-combustible = Rs. 2,17,631

Total Rs. 3,02,759

Thus has the problem of disposing of the refuse of this important Eastern city been set at rest for probably the next quarter of a century.

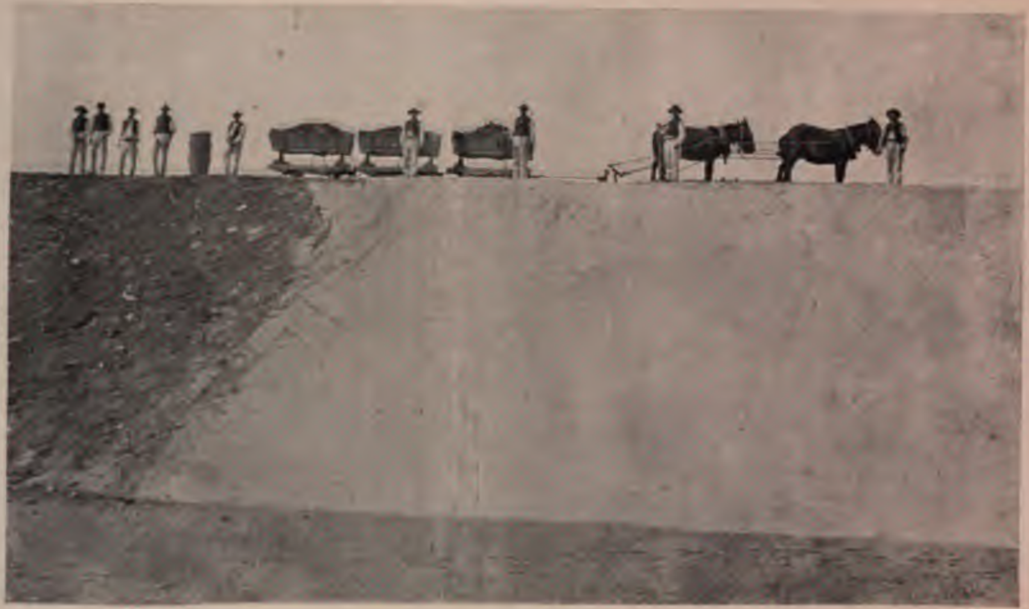

FIG. 55.—CONVICTS ON REFUSE TIPS AT PORT ELIZABETH.

(To face page 256.)

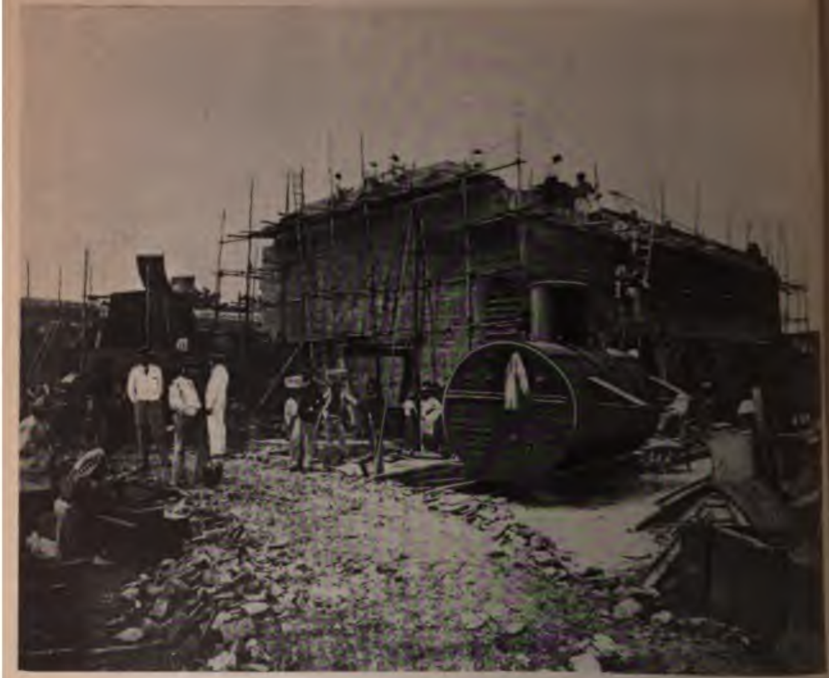

FIG. 56.—HORSFALL'S DESTRUCTOR IN COURSE OF ERECTION AT PERNAMBUCCO, BRAZIL.

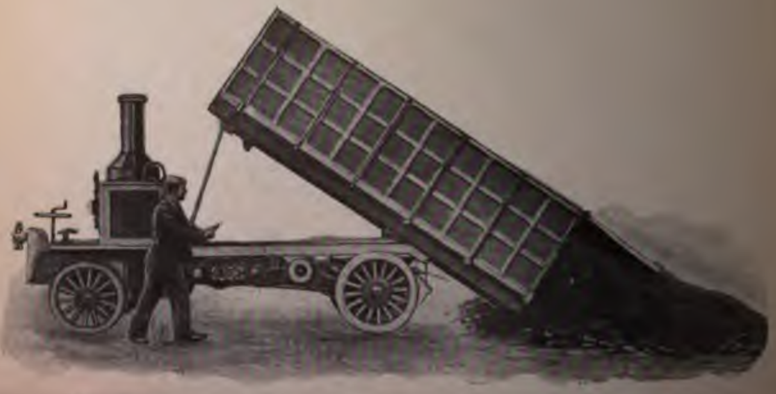

FIG. 57.—COULTHARD'S FIVE-TON STEAM WAGON. CAPACITY 11½ CUBIC YARDS.

CHAPTER XXI.

South America.

Pernambuco (Brazil).—Here the Horsfall Destructor Co., Ltd., have erected a 4-cell installation with a multitubular boiler. An illustration of same is shown herewith. (See Fig. 56.)

Para (Brazil).—Messrs. Manlove, Alliott and Co. erected a small plant here some years ago; recently a 4-cell Horsfall Destructor has been erected.

Buenos Ayres.—The municipality are just now considering plans and tenders for a large installation, and it is to be hoped that something will be done, as it is a very serious matter indeed for a tropical city with a population exceeding one million to be without any sanitary means of refuse disposal. In the past large quantities have been tipped, and as pointed out in the chapter on "Refuse Tipping," this practice has not been without its effect on the death rate.

Bahia, Rio de Janeiro, Rio Grande, Monte Video, San Paulo.—This group of very large and populous South American cities have so far done nothing towards getting rid of their refuse in a sanitary manner.

Manaos—State of Amazonas.—I think it will be news to the vast majority of sanitarians in this country that the above city, one of the chief Amazonian cities, has actually adopted a destructor, and the authorities are very seriously considering the adoption of a modern system for dealing with the sewage.

The destructor is on the improved Colwell system, manufactured by Messrs. Joseph Baker and Sons, and consists of 3 cells, each of a capacity of ten tons per 24 hours. Placed between the cells are two Hornsby Water Tube Boilers each of 105 horse-power.

The waste heat is to be used for the production of steam for electric lighting, and with that in view the General Electric Company are supplying four Peel-Hawkins' continuous current shunt wound dynamos, coupled direct to four tandem compound engines supplied by Messrs. Alley and Maclellan, of Glasgow.

Georgetown, British Guiana.—Messrs. Manlove, Alliott and Company also erected a small Fryer Destructor here a few years since.

CHAPTER XXII.

AUSTRALASIA.

MELBOURNE, SOUTH. — A 12-cell Fryer Destructor was erected here by Messrs. Manlove, Alliott and Co. over [illegible] years ago. As a rule six cells are sufficient to deal with the available refuse; the cost per ton destroyed is 2s. 6¼d. A cremator is used occasionally, and fired with coke, and as this costs about 18s. to 20s. per ton, no doubt it will tend to run up the cost per ton of refuse dealt with.

MELBOURNE, VICTORIA.—Here a 2-cell "Cracknell" Destructor was tried; this is an Australian patent, and would appear to have done very satisfactory work indeed. Each cell had a capacity of over 20 tons per 24 hours, the cost per ton destroyed being 1s. 7d. only. The City Surveyors of Melbourne, South Melbourne, and Richmond, in their report, comment most favourably upon the Cracknell Destructor.

A 2-cell destructor of this type has also been erected in the City of Fitzroy, and in entering into the contract with the Municipality Mr. Cracknell guaranteed "to consume at least an equal quantity of refuse with two of his cells as can be consumed with eight Fryer cells, the refuse to be of similar character. The entire work to be built in the colony, under the supervision and to the approval of the Surveyor to the City."

SYDNEY, N.S.W.—Mr. Richards, the City Surveyor of Sydney, made a tour of inspection two years since, visiting many installations in England. Upon his return he furnished a report to the Council recommending Messrs. Goddard, Massey and Warner's destructor as being the most suitable for adoption in Sydney, but I understand that, although tenders and plans have been sent in long since, nothing has yet been done.

ADELAIDE.—The Corporation some time ago floated a loan of £5,000 for the erection of destructors; at that time the Pinhoe Destructor, a native Australian patent, was the favoured type.

In the past the refuse has been tipped on the Park Lands, the lungs of the city. It is alleged that a deal of illness among children has been traced to their playing among the rubbish heaps—monuments of municipal wisdom erected on land set apart for the health of the people.

Here is shown a plan of Adelaide with the refuse tips marked and also site for proposed destructor. Lately the municipality

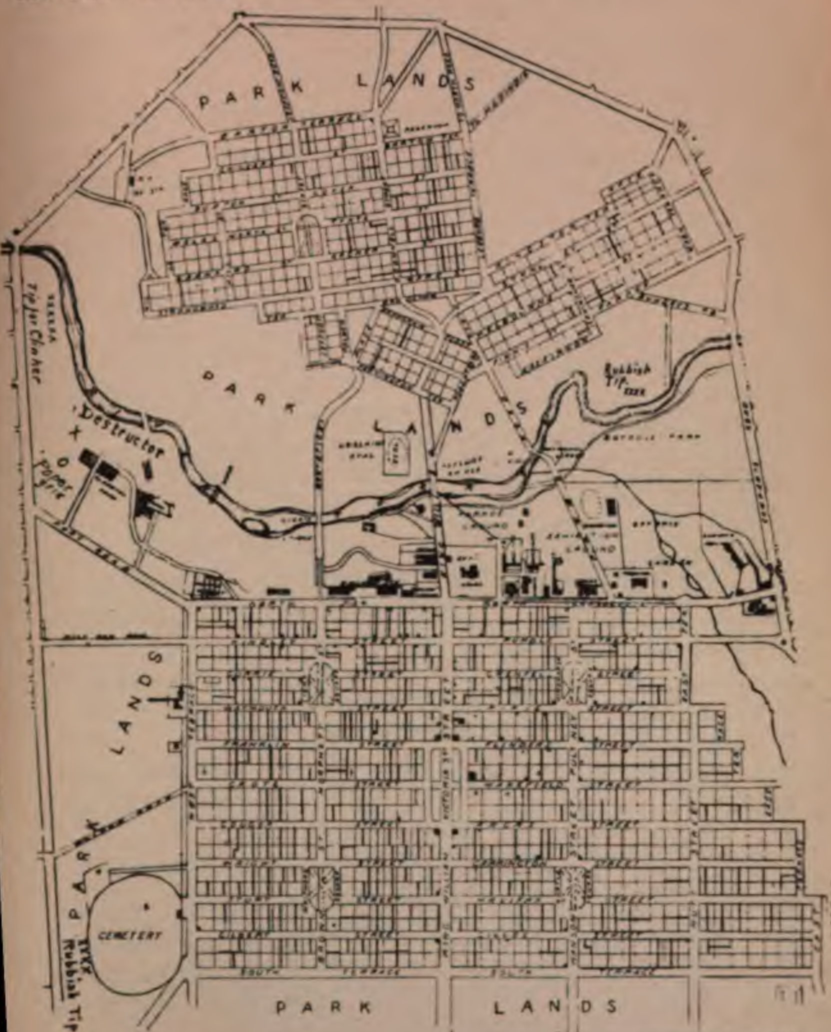

FIG. 58.—PLAN OF CITY OF ADELAIDE, SOUTH AUSTRALIA, SHOWING REFUSE TIP IN THE PEOPLE'S PARK, ALSO SITE FOR PROPOSED DESTRUCTOR.

have invited tenders from British destructor makers for a destructor to the following specification. On perusal it will be seen that some of the clauses are simply prohibitiv scarcely to be expected that makers in this country w keen on securing the contract.

City of Adelaide.

The Municipal Council of the city of Adelaide here tenders :—

(*a*) For the erection of a refuse destructor, and worki for six months in accordance with specifications.

(*b*) For the erection of a refuse destructor and workin for seven years at   per annum.

(*c*) For the erection of a refuse destructor, and collectio treatment of refuse for seven years at   per annum.

(1) The maximum quantity of garbage collected by 12 of 70 cubic feet capacity each, is about 34 tons per day of hours, the average being 30 tons per day.

(2) Garbage weighs about 10 cwt. per cubic yard.

(3) Collections are made twice weekly from about 8,000 ho and buildings.

Extract from Specification.

The plant to be of high temperature type, embodying all latest improvements, and capable of dealing with 40 tons garbage in 10 hours.

Cells to be provided with hopper arrangement with a capaci of not less than 70 cubic feet for charging purposes.

The Corporation will erect the inclined roadway.

Garbage consists of food scraps, market refuse and hous sweepings, and the usual sundry materials, but little cinder, and must be dealt with unscreened.

New Zealand :—

WELLINGTON.—Messrs. Manlove, Alliott and Co. erected six Fryer Cells some years ago; within the past year the new surveyor, Mr. Rounthwaite (late of Sunderland), has had under consideration the question of putting down several additional cells.

CHRISTCHURCH.—Tenders were recently invited for a 6-cell destructor for this rising city. The weekly collection of refuse is about 180 tons approximately, made up as follows :—50 per cent. paper and light material, 20 per cent. garbage, 20 per cent.

dust and ashes, the remaining 10 being bottles, tins, and other incombustible waste. Messrs. Meldrum Brothers, Limited, have been awarded the contract for their Beaman and Deas Patent Destructor. As a striking example of how quickly these matters are settled in the Antipodes, it may be of interest to add that the cable accepting the successful tenders was received within 10 weeks from the date of enquiry.

A 4-cell plant is being erected, with two Babcock and Wilcox Boilers, with 1,741 square feet of heating surface, to steam at 200 lbs. pressure.

Tasmania :—

In 1897 Mr. Alderman F. Hart was in England inspecting a number of destructor installations, and upon his return to Tasmania he reported most favourably upon the English system of refuse destruction.

There are a few towns of fair size in the Colony, such as Hobart, Launceston, and Zeehan, where the present methods of refuse disposal are of the most primitive character, and from what Alderman Hart saw he is convinced that English methods of destruction by fire might be adopted, not only with advantage from the sanitary point of view, but also with good financial results.

CHAPTER XXIII.

THE EAST.

SHANGHAI.—Early in 1898 the authorities here had the question of refuse disposal before them, but nothing yet appears to have been done.

PENANG.—Mr. R. Peirce, the Municipal Engineer, visited England in 1898 with a view of inspecting a number of destructors, but the matter seems to have been in abeyance until quite recently, when it has again been revived.

SINGAPORE, STRAITS SETTLEMENTS.—After tipping the refuse for many years on swampy ground at Jalan Besar, with consequences by no means pleasant for those residing near at hand, the late Mr. McRitchie, after visiting Bombay, advised the introduction of incinerators patented by Messrs. Garlick and Christiansen, of that city.

After some delay it was at length decided to acquire land at Jalan Besar and also at Tanjong Pagar, four cells to be erected at the former place, and two at the latter. It is expected that each cell will deal with 10 to 12 tons per day.

In addition to the incinerators the Municipality are erecting an experimental poudrette machine for dealing with four tons of night soil per day, made by Messrs. James Farmer and Sons, Salford ; and of similar design to those in use in Birmingham. Babcock and Wilcox Boilers are also being installed.

The Commissioners hope to find a ready sale for the poudrette among the planters, who import artificial manures at considerable cost from Europe.

COLOMBO, CEYLON.—Here the Municipality have two depôts where the night soil and refuse is taken ; one is at Nawalla, and the other at Demettegoda, and the arrangements for dealing with the night soil and refuse at Demettegoda depôt are of the most primitive character ; trenches are dug, the filth is tipped in, and then covered with earth.

At Nawalla it was decided to erect incinerators for disposing of night soil, and Silchar Incinerators have been installed. This

TABLE FROM REPORT OF THE SHANGHAI MUNICIPAL COUNCIL FOR YEAR ENDING DEC 1899 (MR. CHAS. MAYNE, ENGINEER AND SURVEYOR).

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* PERCENTAGES BY WEIGHT OF THE COMPONENT PARTS OF SHANGHAI GARBAGE FOR EACH MONTH OF THE YEAR, TOGETHER WITH THE COMPONENT PARTS OF AVERAGE LONDON GARBAGE.

COMPONENT PARTS.	SHANGHAI GARBAGE, 1899.												AVERAGE LONDON GARBAGE.
	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Bricks and broken roof tiles	3·497	2·590	1·928	2·684	1·961	2·702	2·260	1·703	2·680	2·860	1·481	1·491	—
Cinders and ashes	27·338	31·257	30·530	27·544	17·167	21·697	12·841	12·224	11·303	10·213	9·972	8·330	69·69
Fine dust	45·285	40·791	42·409	40·798	37·204	43·789	47·630	35·588	31·790	34·511	35·050	32·785	19·51
Vegetable, animal, and various organic matter	13·776	14·750	14·304	17·551	34·121	18·092	23·785	37·745	45·925	44·006	45·552	50·098	4·61
Waste paper	·546	·564	·385	·419	·435	·569	·329	·220	·198	·242	·182	·212	4·28
Straw and fibrous material	8·102	8·694	9·251	9·667	8·094	11·822	11·973	9·380	7·283	7·100	6·749	5·916	3·22
Bottles, unbroken	—	—	—	—	—	—	—	—	—	—	—	—	·96
Coal and coke	—	—	—	—	—	—	—	—	—	—	—	—	·84
Tins	·538	·433	·292	·257	·259	·282	·227	·216	.122	·238	·179	·223	·79
Crockery	·386	·455	·494	·373	·277	·369	·282	·245	·181	·253	·215	·276	·55
Bones	·058	·056	·047	·069	·088	·088	·062	·063	·048	·055	·063	·065	·48
Broken glass	·078	·085	·079	·082	·074	·103	·122	·115	·075	·096	·088	·069	·47
Rags	·182	·141	·122	·172	·161	·222	·227	·182	·169	·178	·179	·196	·39
Iron	·062	·063	·051	·058	·052	·083	·076	·089	·052	·058	·076	·076	·21
Wood	·152	·121	·108	·146	·128	·182	·186	·230	·174	·190	·224	·263	—
	100·	100·	100·	100·	100·	100·	100.	100·	100·	100·	100·	100·	100·

includes cabbage leaves, rinds of water-melon and pumpkin, khobar, feathers, dead cats and dogs, putrid meat, old shoes, fish and fowl entrails, fish heads and bones, refuse from the manufacture of beancakes and Chinese sauce (soy), etc.

* The above figures were arrived at by taking a sample cartload of garbage at random every day throughout the year, and the figures tabulated are a fair average.

type of incinerator is a military invention, and was used the Afridi campaign on the North-West Frontier in 1898.

Fuel of some kind is required to destroy the nigh Nawalla ; I understand they are experimenting with coa gas.

RANGOON, BURMA.—The advisability of erecting destruc has been under consideration here, but as yet nothing has b done, although with the rapid development of Upper Burma highly necessary that sanitary refuse disposal should receive fullest consideration.

At present the refuse and garbage of Rangoon is covered or buried, and the danger of this primitive method of getting out of the way will at once be obvious when it is borne in mind that Rangoon city is only five feet above the sea level. Furthe with the extraordinary development of the country, land is rapidly increasing in value, and it is rightly contended that if is only from the standpoint of economy, the destructor question should be faced at once.

Nothing appears to have been done in the sanitary disposal of refuse in any part of Burma ; the same may be said of India except in a few of the largest cities. The majority of Burmese and Indian municipalities have never heard of a destructor except in the historical sense—as a means of torture.

The majority of Indian towns shoot their refuse on unoccupied land ; also their night soil, and it is left unburied. In a very few places, such as Bhiwani, in the Hissar district, the "Kachera," or house refuse, is mixed with night soil and burned for fuel for the burning of bricks. It will thus be seen that in an elementary way even some of the natives have an idea that the filth can be disposed of by fire, and at the same time serve a useful purpose.

CHAPTER XXIV.

Types of Destructors.

The Fryer Destructor.—With Messrs. Bulnois, Wood and Brodie's Combination.

During the past few years this type of destructor has undergone a number of alterations, principally, however, by the inclusion of the patents of Messrs. Boulnois, Wood and Brodie. The several patents cover charging apparatus, firebars, and methods of boiler setting.

The name of Fryer will always have an honoured place in the record of sanitary refuse disposal in this country, the late Mr. Alfred Fryer having erected the first destructor to achieve any real success.

Modern installations erected by Messrs. Manlove, Alliott and Company, such as Shoreditch, Wakefield, etc., have Messrs. Boulnois, Wood and Brodie's patents included therewith. With regard to charging apparatus, a brief notice only is necessary here, as the various methods of charging cells, including patent mechanical charging, is dealt with in another chapter.

Briefly described, the patent charging apparatus consists of a tank, divided into several compartments, and arranged to travel upon rails over the furnaces. Each compartment will contain sufficient refuse for one charge. Mechanism is provided for opening and closing the charging hole of the furnace.

The firebars are of curious form, taking a rather sharp curve, and are of the moveable or rocking type, alternate bars being moved by toggle gearing, the curve assisting to shift the charge forward, as also tending to assist gravitation.

Artificial draught is usually provided by Sturtevant Fans, in some cases steam driven ; in other cases, as at Shoreditch, they are electrically driven.

With reference to the method of boiler setting, this is referred to in another chapter, and also where the Shoreditch plant is described. One Babcock and Wilcox Boiler is placed or "sandwiched" between two cells, being fired with the gases from right and left. In addition to this method of firing, the boiler is provided with an ordinary grate for coal fired by hand from the front in the usual way.

The advantages accruing from this combination are that the coal-fired grate may be used when the demand for steam is sudden or beyond the capacity of the cells. Further, the coal-fired grate may be used as a cremator.

The combination has been very severely criticised by many engineers of repute, who contend that both coal and refuse should be burned quite independently of each other, to get the best results from both. When coal is being burned under such conditions as exist with the combination, the constant opening of the fire doors allows an inrush of cold air to mingle with the destructor gases just at that point where they impinge against the boiler tubes, thus cooling down the gases.

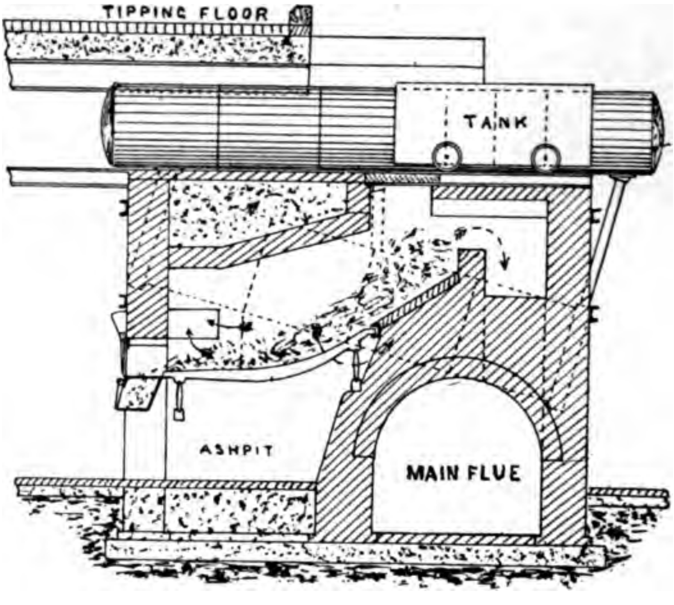


FIG. 59.—THE FRYER DESTRUCTOR CELL, SHOWING MESSRS. BOULNOIS, WOOD & BRODIE'S COMBINATION.

The general design of the Fryer Cell, arranged with Messrs. Boulnois, Wood and Brodie's patents, is here shown in the accompanying plan.

THE HORSFALL DESTRUCTOR.

This destructor, being, strictly speaking, the first to work at a reasonably high temperature, has been, and still is, very popular. No doubt this may be largely accounted for by the fact that many of the old low temperature cells were "converted" to the Horsfall type at a time when destructors were anything but popular, because of their inefficiency.

The advent of the Horsfall may be said to have "stopped the rot" in destructor work, and it must be conceded that it is largely owing to the sweeping change from low temperatures and nuisance to higher temperatures and efficiency that destructors are even as popular as they are to-day, and still steadily growing in public favour.

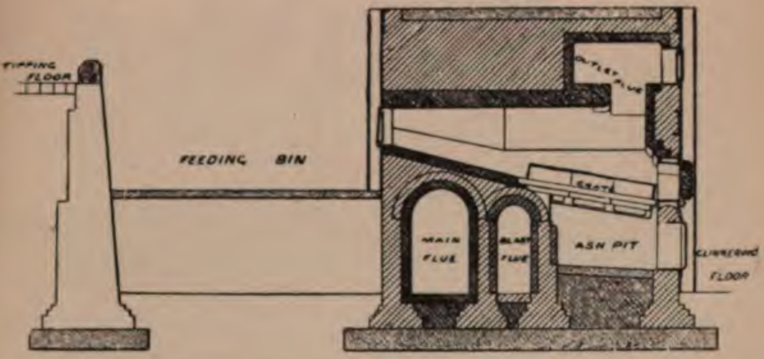


FIG. 60.—HORSFALL'S DESTRUCTOR AS ARRANGED FOR SINGLE ROW.

There can be no doubt that the low temperature type, wit the attendant nuisance many years ago, has been responsible for much of the determined opposition to the adoption of destructors. Therefore, great credit is due to those who have shown that refuse destructor and public nuisance are not synonymous terms.

To briefly describe the Horsfall Destructor, as will be seen from the plans herewith, some of the general features are somewhat similar to the "Fryer," although in detail there are essential differences. This will be specially apparent with the arrangement of the outlet flues for the gases of combustion, as in also the arrangement of the air conduit, through which supply is drawn through side air boxes, thence to the ashpits.

The shape and dimensions of the cells are similar to a standard grate of 25 square feet per cell usually being

Two special features of the Horsfall are the side air between the grate and side wall of cell, through which for combustion passes. These side boxes also tend to the clinker coming into contact with, and adhering to, the walls of the cell.

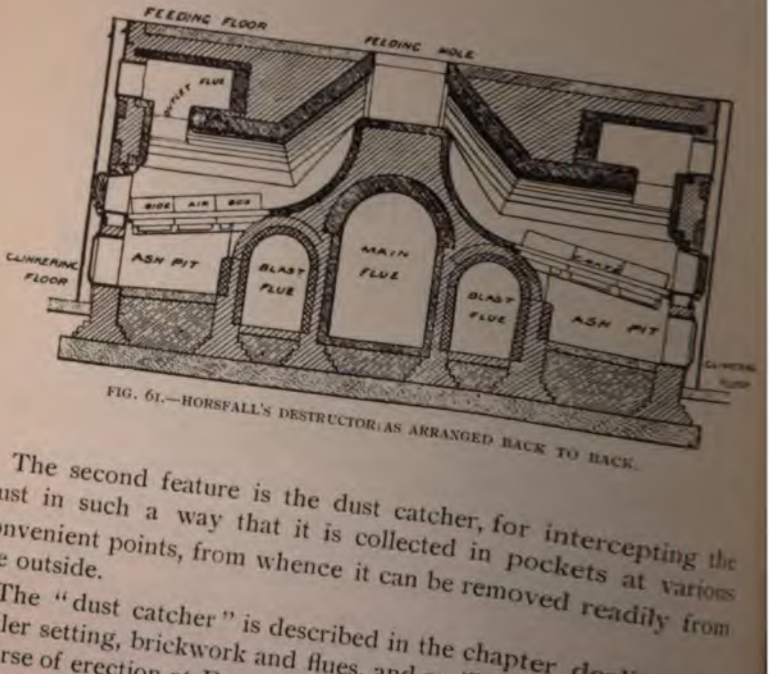


FIG. 61.—HORSFALL'S DESTRUCTOR: AS ARRANGED BACK TO BACK.

The second feature is the dust catcher, for intercepting the dust in such a way that it is collected in pockets at various convenient points, from whence it can be removed readily from the outside.

The "dust catcher" is described in the chapter dealing with boiler setting, brickwork and flues, and an illustration of one in course of erection at Ramsgate is shown.

The accompanying plans will make the general principle of the Horsfall quite clear. The back to back arrangement of cells is a very compact one. In this case it will be noticed that the charging hole is arranged centrally common to two cells.

THE WARNER "PERFECTUS" DESTRUCTOR.

In casually glancing at the accompanying plan, it will be noticed that in general principle the cell is in some respects similar to the "Fryer." With the "Fryer" also it has been largely adopted, over 500 cells having been erected.

One essential difference as compared with the "Fryer" is the charging arrangement, which consists of a hopper with a moveable base plate, operated with a lever. The hopper having been charged, a plate is put on top of the charge to prevent the escape of fumes. The lever is then moved, releasing the bottom door, and the refuse is precipitated on to the drying hearth.

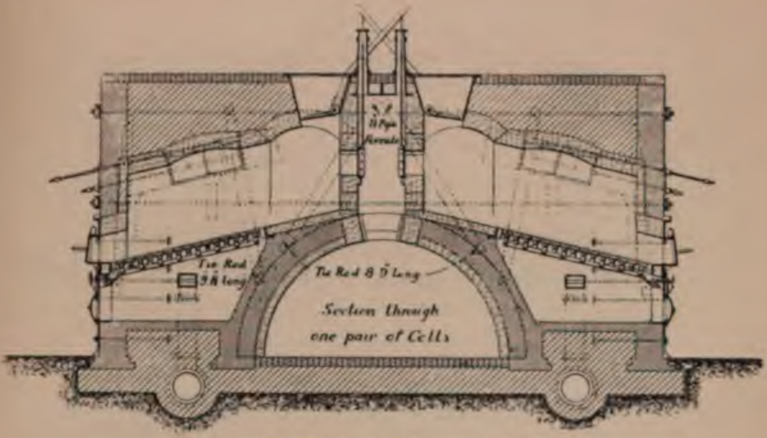


FIG. 62.—THE WARNER "PERFECTUS" DESTRUCTOR.

With the Warner "Perfectus" a somewhat unusual arrangement of dampers is provided, by which the flue of each cell can be readily closed during the clinkering process, thus aiding the maintenance of a steadier temperature. Special dust catchers are also provided, and latterly Fan draught has been made an integral part of a plant.

The general modern arrangement is one boiler and two furnaces, and rocking bars are used in some installations. The type of damper usually employed is that known as the fla damper, but the general experience has been in several high temperature plants that the ordinary balanced damper is the most suitable, and even then their use should be restricted as far as is compatible with efficiency, as the high temperatures attained are very destructive.

One of Messrs. Goddard, Massey and Warner's most recent installations is fully illustrated elsewhere, also the complete figures of official tests are given, and other interesting data.

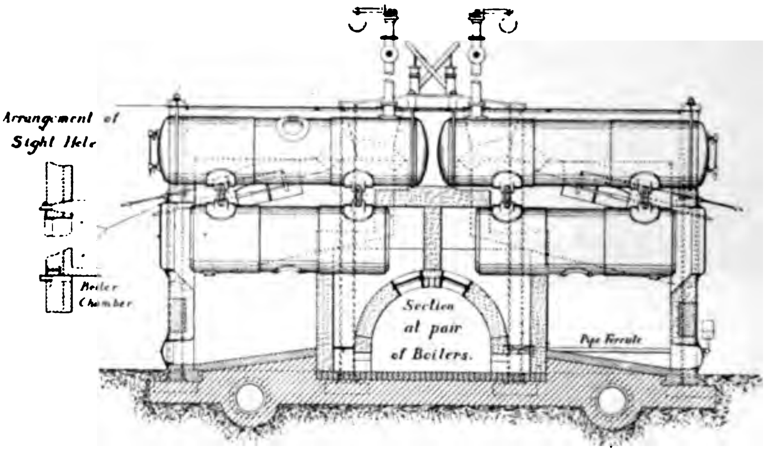


FIG. 63.—THE WARNER "PERFECTUS" DESTRUCTOR.

THE BEAMAN AND DEAS PATENT REFUSE DESTRUCTOR.

This destructor is exceedingly popular; as a good example of a modern high temperature destructor, a description will be of interest.

Destructor Furnaces.—The destructor furnace is composed of two cells, each having a drying hearth on which the refuse from the storage hopper and charging chamber falls. Placed between each of these cells is a common combustion chamber, into which the gases collect, and from thence are taken away through the boiler or bye pass flue, as required. At one end of the combustion chamber is placed a Babcock and Wilcox water tube boiler, through which the gases from the combustion chamber are passed.

Mode of Charging.—The carts containing the refuse pass on to the tipping platform, and are there backed on to the tipping beam of the storage hopper, into which the refuse is tipped.

On the top of the storage hopper is placed a W.I. grid, which prevents large articles from passing into the hopper. This grid is of such an area that any article passing through it will with ease pass through the charging chamber.

When it is necessary to charge the cells, the stoker, who is on the ground or clinker floor, simply turns the chain, which revolves a chain wheel, and that in its turn actuates two square threaded spindles, placed on each side of the storage hopper. These when revolved open a pair of W.I. doors, which are placed at the termination of the storage hopper ; this allows the charge to pass into the charging chamber, which is situated between the storage hopper and the mouth of the cell, directly over the drying hearth.

When the charging chamber is full, all that is required to be done by the stoker is to reverse the action of the chain wheel by means of the chain, which again closes the doors and cuts off any further supply of refuse from the storage hopper. This done, he opens a similar pair of doors communicating from the underneath side of the charging chamber to the drying hearth, which, when opened by the same means as the storage hopper doors, allows the charge to fall on to the drying hearth. By this method of charging the cells the amount of refuse allowed to enter the cells is regulated, so that a more even method of supplying the cells is obtained. This arrangement of charging by the storage hopper and charging chamber entirely dispenses with the services of feed hopper men on the tipping platform level, the stoker himself having complete control of the feeding apparatus, without leaving his furnace. The cost of labour for the burning of the refuse is thus very materially reduced.

The cleanliness of this system recommends itself ; the refuse tipped from the carts passing through the storage apparatus direct to the drying hearth without any handling whatever.

The weight of this charging apparatus is taken by the joists which form the tipping platform, so that no weight whatever is put upon the furnaces.

The termination of the charging chamber is telescoped into a lute shaped casting, which allows the brickwork to expand or contract freely, as the case may be. The refuse delivered by the charging apparatus on to the drying hearth is pulled forward by the stoker on to the grate of the destructor cell and there burned under forced draught, produced by one of Schiele's patent high pressure fans, driven by a Tangye's horizontal engine. The forced draught passing through an air duct, composed of patent jointed earthenware pipes, and communicating to sealed ashpits under the grate area by means of W.I. pipes, at the end of which is placed a W.I. valve, with spindle and handle leading to the outer wall of the furnace, by which the draught is regulated as required.

Construction of Cells, &c.—The cells themselves are constructed of firebricks where exposed to the heat of the gases, the outer walls being of red pressed facing bricks, with blue brick bullnosed corners.

The grate is constructed of firebars of special pattern, supported on steel bearers, on a level with the drying hearth. Round the grate area are built in C.I. dead plates, which prevent any damage being done by the firing and clinkering tools to the firebrick lining.

All the firing and clinkering doors and combustion chamber doors are arranged on one side of the installation, so that the stoker has perfect control over them. These doors are specially designed of wrought and cast iron, with firebrick lining.

The fire bridges of the common combustion chamber are composed of firebricks, and are placed parallel with each other. The bottom of the combustion chamber is constructed of firebricks, and is provided with a false bottom, composed of fireclay tiles, supported by C.I. bearers.

A special vertical damper is also supplied between the end of the combustion chamber and the boiler firing grate.

The cells and combustion chambers are strongly bound together by steel buckstaves, embedded in concrete at the foot, and held together at the top by strong W.I. tie rods.

Particulars of Installation.—The installation is composed of a series of cells with the common or combustion chamber placed between each pair, the fire bridges to the cells being built parallel to each other. This method of construction ensures the gases meeting one another in a straight line in the combustion chamber, thereby ensuring more complete admixture and fusion than hitherto obtained by the system we have adopted up to the present time, the combustion therefore being more perfect.

The cells may be constructed in batteries which can be extended indefinitely in single or parallel series, with one boiler for each pair of cells, as indicated on the plan. This system of placing the cells and boilers effects a very great saving in the space required for plants of any given capacity when compared with the existing system.

Any pair of cells can be isolated from the boiler by means of a vertical damper, or bye passed through the false bottom of the combustion chamber by the removal of fireclay slabs. The present system of connecting the combustion chamber with the boiler, by means of a semi-circular throat seven feet long, is dispensed with, the combustion chamber being built directly on to the side of the boiler. By this arrangement the products of combustion pass directly from the combustion chamber into the boiler and are not subjected to radiation losses as in the case of the throat before coming into contact with the boiler. The calorific value of the refuse, by this new arrangement, is utilised to the fullest extent.

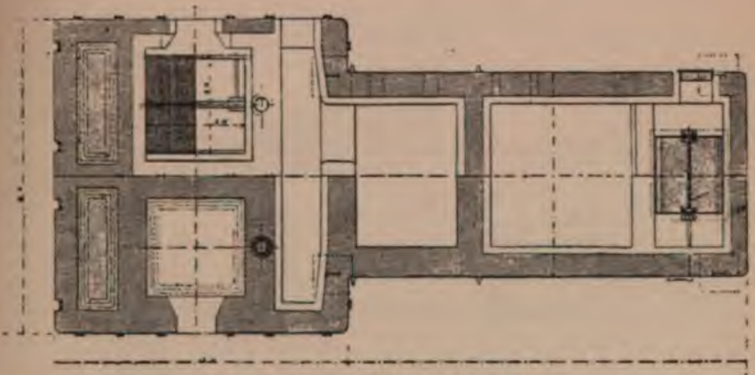


FIG 64.—THE BEAMAN & DEAS' DESTRUCTOR.

It will be noted that the cells are so constructed that the fumes from the drying hearth are bound to pass over the hottest part of the fire and into the common combustion chamber; also that each cell acts as a fume cremator to the other, the method adopted in firing being as follows :—

The cells are fired alternately, so that when one cell is at white heat the second furnace is being fired ; the green gases from the second cell therefore mingle with the gases in the common combustion chamber from the cell at white heat, which effects most perfect combustion of the gases.

A specially-constructed damper is arranged on the top of each fire bridge, which is closed down when fresh refuse is being put on either cell, allowing a very small quantity of the green gases admission into the combustion chamber ; by this means more even steam pressure is maintained in the boiler, which is a very strong point to be considered ; also, in the fire bridge, is constructed a passage which allows oxygen to be supplied to the gases in the combustion chamber, which greatly aids combustion.

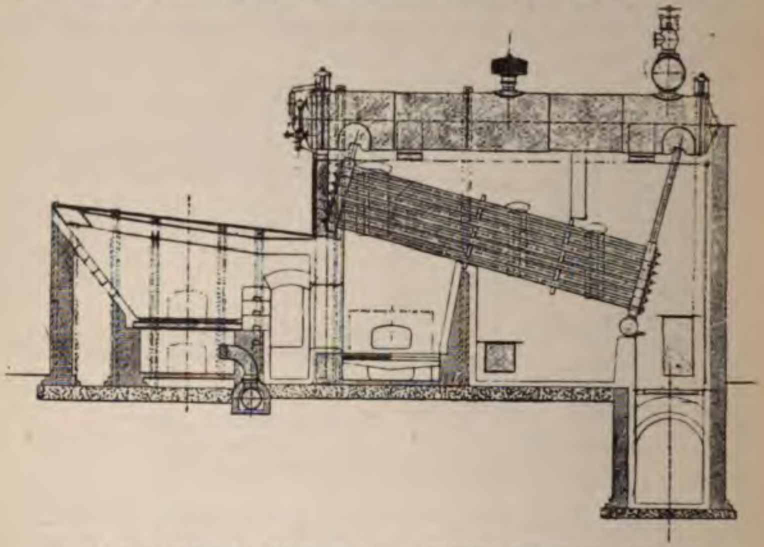


FIG. 65.—THE BEAMAN & DEAS' DESTRUCTOR. SECTION THROUGH CELL AND BOILER.

The proprietors and manufacturers of this Destructor are Messrs. Meldrum Bros., of Atlantic Works, Manchester.

THE WILLOUGHBY REFUSE DESTRUCTOR.

This destructor is constructed on a novel principle, entirely *different* from any other destructor in this country, but very similar to that known as the "Rotary Crematory," of which one was used in New York, and which is referred to in the special chapter dealing with refuse disposal in America.

To briefly describe the Willoughby Destructor, it consists essentially of a furnace and a revolving cylinder or cell. The furnace is not fed with refuse, but with coke, coal or breeze, or a mixture of these, as may be most advantageous, experience with this apparatus having shown that a fair expenditure on fuel far outweighs in advantages the burning of the refuse alone.

The cell consists of a tube of steel or iron 26 ft. long and 7 ft. in diameter at the front end, tapering to 5 ft. at the back; this tube is lined with firebricks. In the tube are projecting ledges, arranged to catch up and throw down the refuse which passes along the depth of the cell. The cell is mounted upon rollers and is caused to revolve slowly by suitable gearing, the speed being regulated according to the nature of the refuse to be treated.

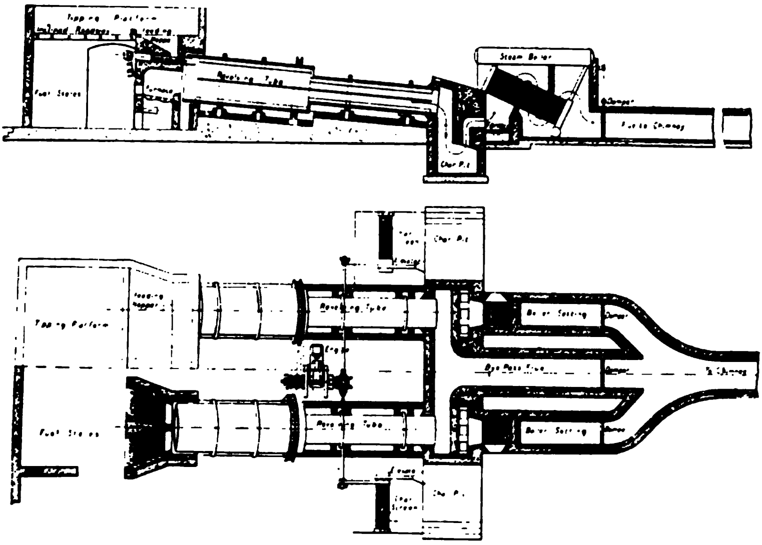


FIG. 66.—THE WILLOUGHBY REFUSE DESTRUCTOR.

Over the furnace at the front end of the cell is a feeding ram which is caused to move forward and backward at such speed as will deliver the requisite quantity into the cell, while the back end of the latter opens into a chamber into which is discharged the unburned residue, the products of combustion passing along a flue to the chimney.

When the destructor is first put into action, the furnace at the front end is lighted, and a few hours are required to get the cells and walls of the chamber up to an incandescent heat. Then the ram is started, and about six times per minute a small portion of the refuse is passed into the hot cell. Thus it will be seen that all the gases evolved have to pass through the fire-brick lined cylinder or cell and then the main flue.

The destructor at Lewisham was the first of this type to be erected; since then another has been installed at Devonport, but this has not satisfied the authorities, and is abandoned. At the former place, instead of the refuse being carted up an inclined roadway, the refuse is lifted up to the feeding ram by an elevator, which seems to involve an expenditure almost equal to the destruction of the refuse; then, of course, the steam for the Meldrum blowers and the engine for driving the revolving cell has to be provided, also from an adjacent boiler.

As to the actual results obtained. It is found that three men can give the necessary attention to enable the plant at Lewisham to deal with 72 tons per 24 hours, but at times a fourth man is necessary. Then it must be borne in mind that coke is necessary for firing the furnace in front of cell.

The inventor of this Destructor is Mr. S. Willoughby, of Plymouth, and it is put on the market by The Willoughby Destructor Syndicate of that town.

MASON'S REFUSE GASIFIER.

The general design of this destructor furnace—or, more strictly speaking, gasifier—is clearly shown in the illustration of the 1-cell plant erected for the Moss Side Urban District Council, and also by the plan here shown.

The cell, which may be rectangular or circular in cross section, is built up of cast iron plates, and lined with firebrick, the top being closed in and provided with a hopper and bell opening for charging purposes. At the bottom the cell is open and supported on two sides across a water trough which covers the whole area of the base, the level in the trough being so maintained at such a height as to effectually seal the interior of the cell from the outer atmosphere. Running transversely across the water trough is a cast iron chamber fitted at the top with two inclined grates above the water level, which form a ridge running from side to side of the cell.

The air required for combustion is supplied by means of a steam jet blower fixed at one side of the cell, the air being blown into the cast iron box described and escaping through the two sloping grates into the mass of burning refuse situated above the water level.

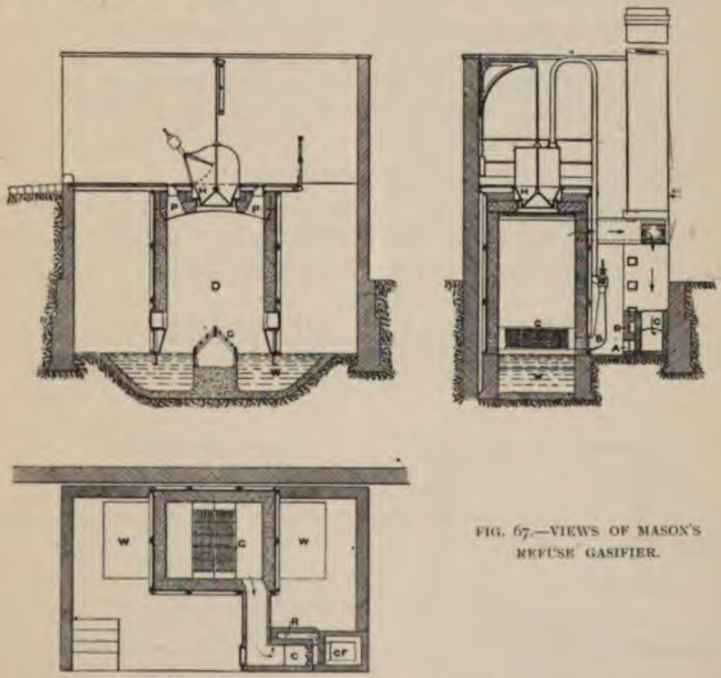


FIG. 67.—VIEWS OF MASON'S REFUSE GASIFIER.

The quantity of air admitted through the blower is limited to that required to maintain a low temperature of combustion of the refuse, and distil off or convert into a gaseous state all the carbonaceous or organic matter with which it is charged. These gases are then led through an opening near the top of the cell into a separate chamber, where they mingle with a secondary air supply, by the aid of which their ignition and complete combustion is secured at a temperature—it is said—of about 1800° Fahr.

The combustion chamber, it will be observed, is
with an annular chamber or jacket. Through this the
air supply is drawn and becomes considerably heated
reaches the gases, thus adding materially to the effic
temperature of the combustion chamber.

Messrs. W. F. Mason, of Manchester, are the maker
type of cell. Among orders they now have in hand
following towns, etc. :—Wellingborough, Smethwick, R
Urban District Council, Withington, and others.

THE HEENAN "TWIN CELL" DESTRUCTOR.

The only destructor of this type at present working
Farnworth, but the makers, Messrs. Heenan and Froude,
Chapel Walks, Manchester, have contracts in hand for
Corporations of Blackburn and Gloucester.

To briefly describe the "Twin Cell" Destructor, as wil
seen from the accompanying illustration, it is partially divi
into two compartments by a central wall, which is, howev

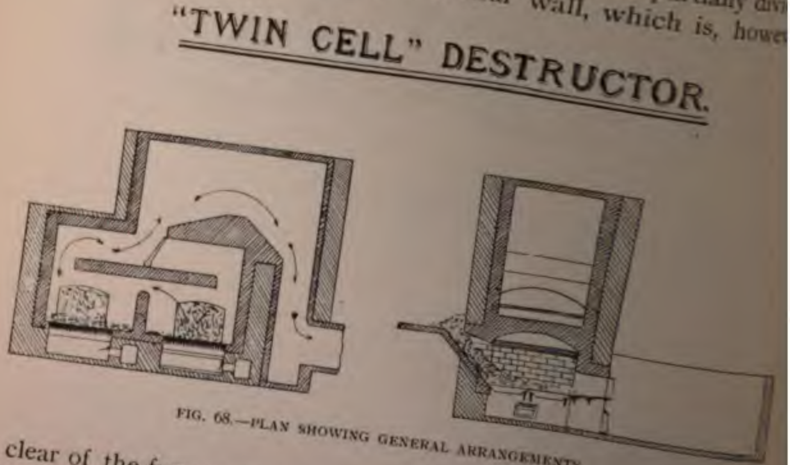


FIG. 68.—PLAN SHOWING GENERAL ARRANGEMENTS.

clear of the furnace crown. There are two charging holes on
the ground level, one to each half cell, so that the refuse can
easily be drawn on to either grate. It is said that this clearance
between the central wall and the crown provides for the gases
passing alternately from one furnace to the other; thus a considerable quantity of refuse is heated before being drawn on to

the fire by the gases passing over it, and that the partially consumed gases arising therefrom pass over the hot fire.

When the cell is at work there are fires on both half grates, one being at maximum temperature when the other is ready for clinkering.

A damper is fixed in the combustion chamber to control the travel of the gases; thus when clinkering begins in one half grate, this damper is thrown over so as to cause all the gases to travel from the half cell in which the maximum temperature exists. The grate, which has been clinkered, is then recharged, and the forced draught applied to same; thus by the time the maximum temperature is reached the other half grate is ready for clinkering; the position of the damper is thereupon reversed.

It will thus be seen that the main principle of the "Twin Cell" is to ensure that low temperature gases distilled from a freshly charged grate or half cell shall have no chance of exit, except through an adjoining half cell, where a high temperature exists, or, to put it another way, one half cell is constantly acting as a cremator for the other half cell, thus doing away with any necessity for the old type of cremator fired with coke or breeze.

THE MELDRUM PATENT "SIMPLEX" DESTRUCTOR.

There are a number of novel points about this type of destructor wherein it differs from any other destructor either at home or abroad, so in order to make them perfectly clear it may be well to take each quite separately.

1. ARRANGEMENT OF CELLS.—The grates being placed side by side, form practically one long cell, which is charged in sections, and as the products of each section pass over the other gases from all the other sections, a complete commingling of the whole volume of gases is secured, thus ensuring a very uniform temperature. With cells as ordinarily constructed the temperature, when newly charged, is comparatively low, especially when the fuel is wet or of low calorific value, and a considerable time elapses before the full temperature is regained, whereas with the above arrangement of cell it is claimed that the maximum temperature is practically secured from the start, owing to the close proximity of the incandescent fuel and the hot gases passing

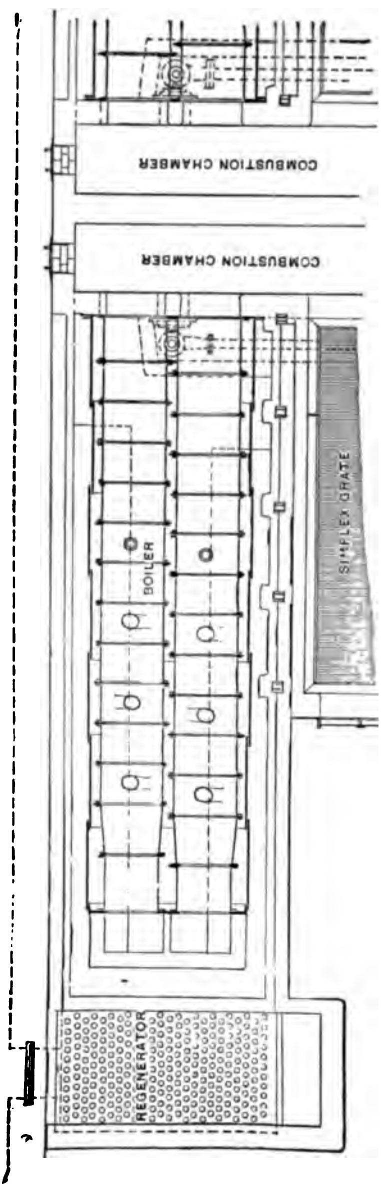


FIG. 69.—MELDRUM'S PATENT SIMPLEX DESTRUCTOR.

over the top of the newly charged refuse. After passing over the bridge common to all the grates, the products of combustion enter a spacious combustion and settling chamber, where the temperature ranges from 1800° to 2000° Fahr., according to the rate of combustion in the cells; thence the gases are passed through and around steam boilers.

2. Regenerator.—After leaving the boiler the remaining heat in the waste gases is still further utilised by heating the air supply for the furnaces. This is accomplished by means of the air heater or continuous regenerator, which consists of a number of specially constructed cast iron pipes, through which the waste gases pass, the cool air circulating round the outside of the pipes, whence it is delivered (heated) through Meldrum Patent Blowers at a temperature exceeding 300° Fahr.

It is claimed that this is of special value in dealing with refuse of varying quality, very often heavy in moisture; this is one of the novel points about this type of destructor not embodied in any other.

3. HANDFIRING.—As to the firing of the cells, here again is an ntirely new departure; the refuse is fired direct on to the grate, as is the case with a hand-fired boiler. It is claimed for his system that the refuse is at one operation put in its proper place, with a specially constructed shovel, the contention being that with other systems the refuse is fed into the top of cells, sometimes several hundredweight at a charge, in a heap, which has then to be levelled, raked, and dragged, this work being exceedingly arduous with high temperature cells. Of course, opinion is much divided upon the labour question, the advocates of the top feed claiming that it is far the best from the labour-saving point of view. However, this much is certain; it is well known in burning coal that to get good duty, and the fuel well burned, one must "fire a little at a time and often," and it seems to me that there is no reason why this old and well-worn advice should not turn out quite as effectively in burning refuse.

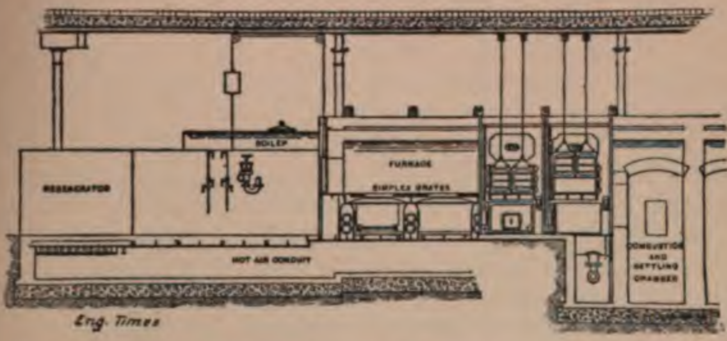


FIG. 70.—MELDRUM'S PATENT SIMPLEX DESTRUCTOR. PART SECTION, AND PART ELEVATION, SHOWING FEEDING AND CLINKERING DOORS.

4. FIRE DOORS.—The fire doors are also a new departure, being in two parts, lined with firebrick and worked with a counterbalance weight, so that only one half need be lifted at one time, thus screening the fireman from the intense glare of the fire. Complete plans of this type of destructor are here shown.

The patentees and manufacturers are Messrs. Meldrum Bros., Ld., Atlantic Works, Manchester.

BAKER'S REFUSE DESTRUCTOR.

This is in many respects a new departure in destructor design as will be seen by the accompanying plans. Messrs. Baker have a reputation as makers of patent ovens, and they claim that their experience in this connection qualify them as designers of a good refuse destructor.

The only installation yet working in this country is at Phœnix Wharf, Lambeth, erected for the Clerkenwell Vestry. A process of screening and sorting is carried on at this wharf, and the material passed through the cells consists for the most part of light refuse, paper, straw, stable refuse, etc., probably of little calorific value, but at the same time capable of being very readily burned. As this destructor is never called upon to deal with the many ingredients which go as a rule to make up the average town's refuse, it is really difficult to form an opinion as to how this type of destructor would acquit itself with ordinary unscreened refuse, often containing a large percentage of objectionable matter.

However, the design is novel and there are what would seem to be some good points about it. The two cells, each with forty-two square feet of grate area at Phœnix Wharf, are each said to be capable of dealing with from eighteen to twenty hundred weights per hour, of the particular class of refuse delivered there, but it will be noticed that the grate area is large, and also that the material to be dealt with is likely to be consumed very rapidly, therefore again one cannot very well decide as to what quantity of ordinary unscreened towns' refuse each cell could deal with per hour.

The cells are so sunk that the refuse is fed into them from the ground level direct on to the inclined drying hearth, the grate proper being placed below this at an angle, at the back of the drying hearth, and at that point where the material is fed on to the grate proper is placed a door for stoking purposes, and from this point the refuse is manipulated and levelled on the fire grate. At the other end of this grate and opposite to the stoking door, is the clinkering door at a slightly lower level, as is customary with all cells, for obvious reasons.

Above the drying hearth on the left will be noticed an exhaust flue, so arranged that the fumes evolved during the drying process shall pass through here and finally be passed through the ıre below; it is thus claimed that all fumes distilled from the naterial while on the drying hearth shall be so employed as to become innocuous. The only difference between this arrangement and the system employed as a rule with the common drying hearth, is that in the latter case all fumes evolved are caused to pass through the hottest part of the fire and the combustion chamber, which must assuredly serve quite as efficiently to secure their thorough cremation.

In the Clerkenwell plant, which is illustrated in another chapter, it will be noticed that a water tube boiler is placed between the two cells, supplying steam for the fan; a dust collector is also placed at the base of the chimney.

It will be seen from the plan herewith that some recent improvements are now embodied in the Baker cells. The drying chamber has been converted into a storage hopper with a capacity of ten tons, the exhaust flue being still retained at the top of the chamber; this storage arrangement has not yet been put to a practical test; how it will do in actual every day work remains to be seen. At first sight it would appear to be no easy task for the stoker at his door to endeavour to cover his grate when he has to drag from the bottom of a ten ton mass. This difficulty appears to have been foreseen by the makers, who have provided a check door to regulate the supply of refuse on the drying hearth. I make no further comment *re* this; actual work will show.

Storage under good conditions is sometimes very useful, but generally speaking it is not in favour; refuse has been stored long enough on tip, the old methods were storage methods; the present practice, more especially, perhaps, in the case of power destructors, rather demands that refuse shall be disposed of as quickly as possible after arrival, so that the greatest quantity can be put through in the shortest time yielding the maximum of power, when that power can be most usefully employed.

That being so, then, the ideal destructor should be that one in connection with which the collection of refuse can be so arranged as to take place simultaneously with the time when the maximum of power can be utilised. I merely mention this in passing—Messrs. Baker apparently only recommend storage because they claim that they can so store refuse that no nuisance is possible. In the ordinary way no doubt Messrs. Baker would agree that storage is not to be recommended.

Another feature introduced by Messrs. Baker in their improved design, as will be seen, is a tipping deadplate at the clinkering door, so arranged that the clinker, as drawn from the fire, can be discharged through a vertical downtake into a continuous conveyor flue, below the ground level preferably; this flue is also connected with the exhaust flue previously mentioned, so that any fumes given off from the clinker may also be conducted to the fire. A sprinkling arrangement is also proposed in connection with the conveyor flue, so that the travelling clinker may be cooled in transit.

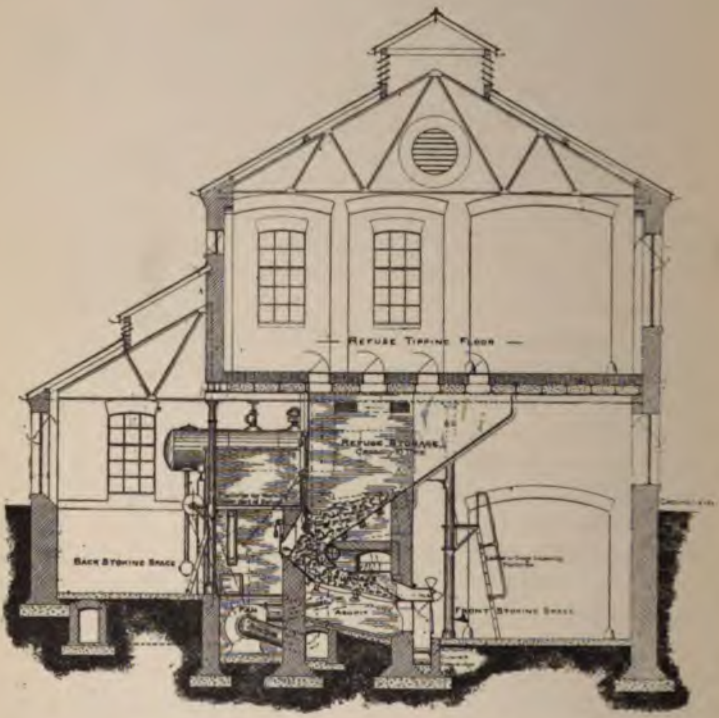


FIG. 71.—BAKER'S IMPROVED DESTRUCTOR.

THE ACME DESTRUCTOR.

The Acme Destructor was patented some years ago by Messrs. Hart and Royle, of Stretford, Manchester. In 1894, Mr. H. Royle, A.M.I.C.E., introduced the destructor in a paper read before the Sanitary Congress meeting at Liverpool; but little, if any, headway appears to have been made since.

The Acme Destructor has several novel points. The refuse is first tipped into a large receptacle or hopper, from which it gravitates on to a sloping grate set at an angle of forty-five degrees. As the organic and combustible portion burns out, the residual material is said to gravitate to the lowest portion of the grate, from whence it is removed by the clinker man with a long shanked shovel.

As quickly as it is removed a further quantity gravitates down the inclined plane formed by the bars, which in its turn is followed by a fresh portion from the hopper, thus it is claimed that the feeding in of the material is almost as gradual as though rocking bars were employed. A hanging bridge is provided; any vapour evolved from the raw material is deflected partly over the surface and partly actually through the incandescent portion moving towards the clinkering door; the gases pass thence through combustion chambers arranged for the settlement of dust and the mingling of the gases.

As each spadeful of clinker is removed it is followed through the whole system by an equal volume of the raw material, the volatile matter from which being thus slowly evolved has ample time for complete combustion, providing the temperature maintained in the combustion chambers is efficiently high.

As originally suggested it was to work with natural draught only, but it could be arranged for artificial draught.

As far as I have been able to enquire, this type of destructor has not yet been adopted at any place for dealing with town's refuse.

General experience shows that refuse will not gravitate to any appreciable extent, without some assistance from a moveable grate, and even then serious difficulties have been found in actual practice. This is evidenced by the very few installations where moveable grates are now in use.

THE PNEUMA DESTRUCTOR.

This is on somewhat similar principles to the fire closet described and illustrated in the chapter entitled "Refuse Disposal in America." It was designed and patented by Mr. R. Howden, of Johannesburg, with a view to improving the sanitation of the mining centres in the Johannesburg district by destroying the excreta.

To briefly describe the cremator. It consists of two oblong receptacles placed side by side, covered on top with cast-iron plates, the inside being lined with stock bricks built into fire clay. Each top plate has nine holes, each 2 ft. 6 in. apart. At either end of each receptacle small furnaces are placed, the inlet of air to which is under the firebars, and the outlet or draw-off pipe is connected with the middle of the receptacles, leading thence to the chimney stack of the mine, from whence the draught is obtained.

This pipe and the draught caused by the chimney are the main principles in the working of the arrangement. The excreta is deposited through the holes directly into the receptacle itself, on to a grating fixed six inches from the bottom, and under which a continuous current of heated air from the two furnaces is carried. The smell and fumes from the deposits and the burning off, are all carried away by the draught, which is, of course, continuous, so that when any lid is lifted the opening simply acts as an inlet, and not as an outlet. As the moisture is evaporated from the excreta by the heated air the mass decreases in bulk from a thickness of twelve inches down to one inch; the remaining one inch of solid or dry matter burns off to a very small quantity of ash.

At the Bonanza Mine, where the first cremator was put up, some 600 boys from the compound deposit into same every day, and the whole of the excreta is disposed of in the manner indicated, at a cost of 2s. per day, this being the cost of one and half bags of coal for the furnaces.

an [illegible]

th [illegible] tor is most favourably reported upon by both

v [illegible] da, Inspector of Mines, Sanitation Dep [illegible]

cooled in [illegible] er, Medical Officer, Johannesburg.

Report by Dr. W. E. St. L. Finny, Mayor of Kingston-on-Thames, 1896 :—

The average cost of constructing a destructor, exclusive of site	£840 per cell
The average annual cost of working each cell	£96
The average cost of destruction per ton ...	11½d.
The average labour per cell	1·17 men
The average work done (8-hour shifts) per man	8 tons
The average wages of stokers per week ...	30s.
The average population dealt with per cell...	1,000
The average weight of refuse dealt with per 24 hours per cell	5 tons
The average height of chimney	163 feet
The average cost of chimney to erect per foot	£6 3s. 4d.
The average time between charging and clinkering a fire	1¼ hours
The average refuse contains	⅓ water by weight
" "	⅓ combustible
" "	⅓ incombustible

DETAILS OF EVAPORATIVE TESTS IN CONNECTION WITH DESTRUCTORS.

COMPILED BY THE SURVEYOR OF NELSON, LANCASHIRE.

TOWN.	Type of Furnace.	Test made by	Duration of Test.	Quality of refuse.	Total weight of refuse burned.	Weight of Refuse burned per hour.	Total weight of water evaporated.	Water evaporated per hour.	Water evaporated per lb. of refuse burned.	Average steam pressure.	Temperature of feed water.		
			hrs.		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.			
...	Horsfall ...	Lord Kelvin ...	24	Unscreened ...	71,320	2,972	78,900	3,287	1·16	128	57° F.	4 cells	Average ·945
...	Do. ...	Do. ...	24	Do. ...	106,980	4,457	78,100	3,254	·73	128	57° F.	6 cells	
rd ...	Do. ...	Mr. Cox, C.E. ...	...	Do. ...	721,280	5,115	523,000	3,709	·725	60	50° F.	6 cells	
Huddersfield ...	Do. ...	Mr. Campbell ...	24	2 refuse to 1 of sludge	70,560	2,940	83,040	3,460	1·17	61 to 71	Cold	2 cells	
Rochdale ...	Meldrum ...	Mr. Brookman ...	6	Unscreened ...	25,536	4,256	42,072	7,012	1·64	113	53° F.	2 cells	Average 1·5 lbs. water to 1 lb. refuse
Do. ...	Do.	Manager, Manure Works	6½	Do. ...	30,800	4,738	42,900	6,600	1·39	113	52° F.	2 cells	
Do. ...	Do.		6½	Do. ...	32,142	4,945	47,400	7,290	1·47	113	52° F.	2 cells	
Hereford ...	Do. ...	Mr. J. Parker ...	10	Do. ...	19,768	1,976	26,254	2,625	1·32	70	48° F.	1 cell	Average 1·30
Do. ...	Do.	Borough Engineer ...	10¼	Do. ...	19,012	1,855	25,570	2,494	1·34	70·2	48° F.	1 cell	
Do. ...	Do.		10	Do. ...	19,712	1,971	20,800	3,287	1·51	70·02	48° F.	1 cell	
Warrington ...	Beaman & Deas	Mr. F. Bennett...	6	Radcliffe refuse	21,700	3,617	22,000	3,666	1·01	45	141·5° F.	2 cells	Average 1·23
Do. ...	Do.	Huddersfield Engineer ...	5⅝	1½ refuse 1 sludge	25,088	4,363	32,000	5,565	1·27	...	65° F.	2 cells	
Do. ...	Do. ...	Mr. Darley ...	24	Unscreened ...	53,544	2,231	61,344	2,556	1·14	68	104° F.	2 cells	
Do. ...	Do	Warrington Corporation ...	5⅜	Do. ...	18,509	3,173	27,791	4,766	1·5	53	135° F.	2 cells	
Leyton ...	Do. ...	Sir Douglas Fox	12	2 refuse to 1 sludge	74,956	6,240	31,020	2,600	·426	105	63° F.	2 cells	

DETAILS OF I.H.P. OBTAINED FROM DESTRUCTORS.

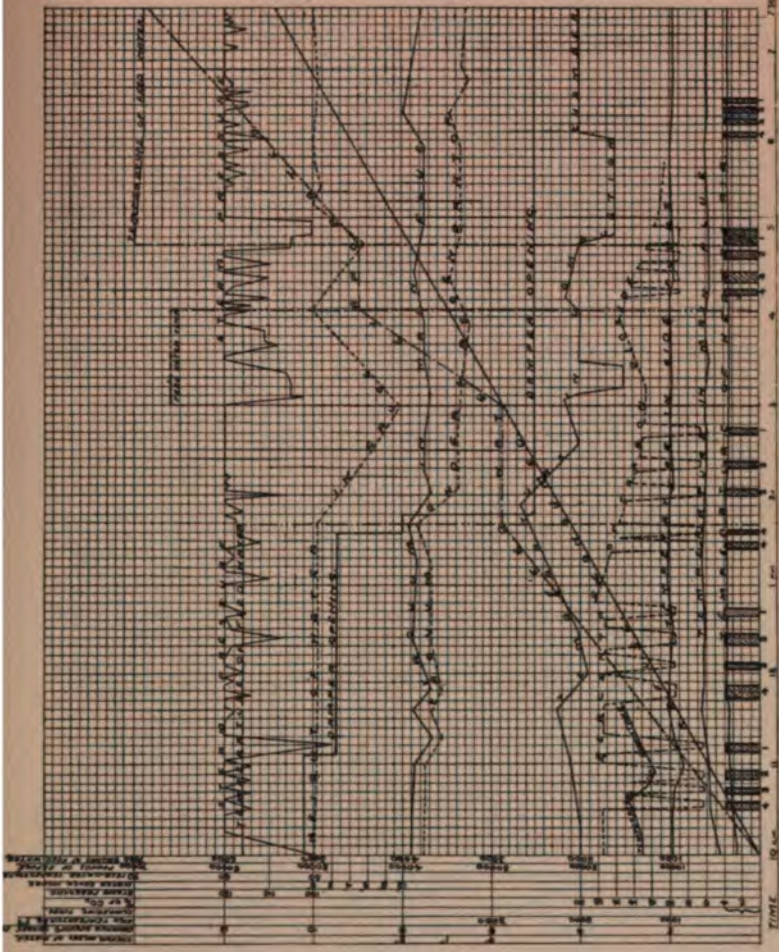
COMPILED BY B. BALL, ESQ., A.M.I.C.E., BOROUGH ENGINEER, NELSON.

Name of Town.	No. of Cells.	Makers.	Quantity of Refuse burnt per cell per day in tons.	Total Quantity burnt per day in tons.	Number and Type of Boilers.	Total I.H.P. obtained.	I.H.P. per ton burnt in 24 hrs.	
Bath	8	Warner's.	5	40	1 Multitubular, 14 ft. by 8 ft.	Drives 20 H.P. Engine.	·5	
Batley	6	Fryer's.	3½	21		" 30 " "	1·43	No night work.
Battersea	12	Do.	6	72	1 60 H.P. Multitubular.			
Blackburn ...	8	Do.	6	48		" 45 " "	·93	
Hammerton Street, Bradford ...	12	Horsfall's.	9·13	54	2 Multitubular, 11 ft. by 8 ft.	" 185 " "	3·42	6 cells working, quantity increased now.
Bury	4	Fryer's.	6·5	26		" 12 " "	·46	
Dewsbury... ...	2	Beaman & Deas.	15	30	1 Babcock.	" 80 " "	2·6	
Ealing	7	Fryer's.	4·5	31		" 35 " "	1·12	Refuse and Sludge mixed.
Hereford	2	Meldrum's.	19	38	2 Galloway, 22 ft. by 6 ft. 6 in.	" 236 " "	6·21	
Meanwood Road, Leeds	8	Horsfall's.	7	56	2 Babcock.	" 265 " "	4·73	
Needham Street, Leicester ...	6	Fryer's with Biddles bars.	9	54	1 50 H.P. Multitubular.			
Leyton	8	Beaman & Deas	16·2	65	2 Babcock.	" 90 " "	1·38	Refuse and Sludge, working 4 cells at once, H.P. available.
Oldham	10	Horsfall's.	8	80	2 Lancashire, 30 ft. by 8 ft.	" 200 " "	2·5	
Rochdale	2	Meldrum's.	23	46	Do.	" 350 " "	7·6	
Southampton ...	6	Fryer's.	10	60	Multitubular.	" 40 " "	·6	
Warrington ...	4	Beaman's.	15	60	Babcock.	Drives about 300 H.P. Engine.	5·0	

TABLE OF RESULTS STANDARDISED. BY BRIERLEY DENHAM HEALEY, ESQ.

Reprinted from "THE MECHANICAL ENGINEER."

		1	2	3	4	5	6
A	Type or system of plant	MELDRUM BROTHERS	HORSFALL FURNACE CO.	STANDARD FURNACE CO.	WOOD AND BRODIE	WARNER'S PERFECTUS	BEAMAN AND DEAS
B	Number of furnaces or grates	4	4	4	4	4	4
C	Grate area in use, in square feet	104	100	108	108	100	100
D	Number and type of boilers	1 Lanc.	1 Tubular	2 W. Tube	2 Tubular	2 Tubular	2 W. Tube
E	Heating surface, in square feet	915	1,830	2,236	2,000	1,620	1,940
F	Tons of refuse burned per diem	31·99	31·84	40·66	33·50	32·00	64·06
G	Burned per foot of grate per hour ...	28·8 lbs.	20·8 lbs.	35·1 lbs.	28·9 lbs.	29·9 lbs.	59·8 lbs.
H	Steam pressure in lbs. per square inch ...	180	128	120	150	81	105
I	I.H.P. of steam per hour	231	158	159	155	102	126
J	Moisture in refuse	20 per cent.	22 per cent.	18 per cent.	20 per cent.	26 per cent.	35 per cent.
K	Clinker residue	31 „	33 „	36 „	32 „	29 „	31 „
L	Combustibles by difference	49 „	45 „	46 „	48 „	45 „	34 „
M	Cubic feet of refuse per ton	54	52	73	65	54	56
N	Water evaporated at and from 212° F. per lb. of refuse	1·55 lb.	1·06 lb.	0·84 lb.	0·99 lb.	0·68 lb.	0·42 lb.
O	Wages per ton of refuse burned	11·00d.	10·50d.	10·60d.	12·20d.	10·29d.	14·50d.
P	Value of steam generated	11·00d.	8·00d.	5·85d.	7·00d.	4·86d.	2·97d.
Q	Net cost of destruction	0·00d.	2·50d.	4·75d.	5·20d.	5·43d.	11·53
R	Temperature of gases in the combustion chamber	1633° F.	2000° F.	1950° F.	1950° F.	1850° F.	1950° F.
S	Temperature near chimney	585° F.	590° F.	465° F.	580° F.	495° F.	480° F.
T	Forced draught pressure	1·80 in.	1·37 in.	1·25 in.	0·90 in.	1·00 in.	1·70 in.
U	Furnace induced draught	0·37 in.	0·37 in.	0·35 in.	0·35 in.	0·30 in.	0·30 in.
V	Type of blowers used	Steam-jet	Steam-jet	Sturtevant	Sturtevant	Sturtevant	Sturtevant
X	Efficiency of capital outlay	1·00	0·76	0·73	0·61	0.59	0·52
Y	Amount of royalty	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted



TEST OF MELDRUMS' PATENT REGENERATIVE REFUSE DESTRUCTOR, AT NELSON.—DECEMBER 20TH, 1900.

Water evaporated per pound of refuse, from and at 212° F.	1·516 pounds.
Water evaporated per hour, from and at 212° F., average	865 gallons.
Water evaporated per hour, from and at 212° F., maximum	938 gallons.
Refuse consumed per twenty-four hours, on four grates of 25 each	61 tons.

NOTE :—Number 4 fire is next to combustion chamber. (See p. 292).

REPORT OF TEST WITH MELDRUM'S REGENERATIVE REFUSE DESTRUCTOR AT NELSON, DECEMBER 20TH, 1900.

One 4 grate Destructor with one 30′ × 8′ Lancashire Boiler.

Duration of test (10 a.m. to 7.30 p.m.) ... ... 9½ hours.

Refuse consumed :—

	Tons.	Cwts.	Qrs.
Ashpit refuse	**23**	**5**	**3**
Vegetable refuse		**17**	**0**
Slaughter-house refuse		**1**	**0**
	24	**3**	**3**

Refuse consumed. Total lbs.	**54,180 lbs.**
„ „ **per hour**	**5,703 lbs.**
„ „ **per sq. ft. grate per hour**	**57 lbs.**
Water evaporated	**68,580 lbs.**
„ „ per hour (actual)	**7,220 lbs.**
„ „ per hour from and at 212° F.	**8,650 lbs.**
„ „ per lb of refuse (actual)	**1·266 lbs.**
„ „ per lb of refuse from and at 212° F.	**1·516 lbs.**
Average temperature of feed water	**63·4° F.**
„ steam pressure	**118 lbs.**
„ percentage of CO_2 (actual)	**12·21 %.**
„ „ „ „ when not clinkering	**14·4 %.**
Lowest „ „ „ when clinkering No. 3 fire	**6·4 %.**
Highest „ „ „ when not clinkering	**18·2 %.**
Lowest „ „ „ when not clinkering	**10·4 %.**
Average temperature of combustion chamber (readings)	**2000° F.**
Lowest „ „ „ „ by thermophone	**1570° F.**
Average „ in side flues	**982° F.**
„ „ in main flue	**596° F.**
„ loss passing through regenerator	**386° F.**
„ temperature of air entering regenerator	**64° F.**
„ „ „ leaving regenerator	**346° F.**
„ increase of temperature of air passing through regenerator	**282° F.**
„ ashpit pressure	**1·85″**
„ vacuum in blower boxes	**·35″**
„ „ in main flue	**1·53″**
„ „ under regenerator 10 a.m. to 1.40 p.m.	**1·375″**
„ „ „ „ 1.40 p.m. to 7.30 p.m.	**·545″**
Damper full open to 1.40 p.m., area sq. ft.	10·2
„ partly closed after 1.40 p.m., area sq. ft.	5
Average vacuum in downtake 10 a.m. to 1.40 p.m.	**·875″**
„ „ „ „ 1.40 p.m. to 7.30 p.m.	**·375″**
„ time taken to clinker one fire	**5 min. 36 secs**
Number of times each fire clinkered during test	**5**
Average time per clinkering	**1 hour 54 min.**

Remarks.—Boiler not clothed.

Lower half of flue tubes from combustion chamber to boiler uncovered, and top half covered 2½ in thick with non-condensing composition.

The feed pump was heavily taxed to gain on this rate of evaporation.

The main damper was full open at commencement of test, giving 10·2 square feet. No effect upon the vacuum under the regenerator was caused until the damper was closed down so that there was but 5 square feet opening.

The maximum rate of evaporation was attained during the first half of the test. The evaporation during the first 3½ hours was at the rate of 938 gallons *per hour, from* and at 212 degrees Fahr.

CHAPTER XXV.

GENERAL REMARKS.

SEEING that the general trend of refuse disposal, at any rate so far as our own country is concerned, is toward a combination with power production, we are brought face to face with the fact that a percentage of the civic waste cannot very well be cremated.

Street Refuse.—Here I specially refer to street refuse, which, of course, is useless for steam-raising purposes. With some destructors a portion is got rid of at times—I may say favourable times, when there is little demand for steam—but for the most part street refuse is carted away and tipped. In the case of London, it is mostly barged away and shot on to waste land.

Trade Refuse.—Again, in many districts, enormous quantities of what may be called trade refuse or manufacturers' waste is produced, which, generally speaking, the authorities object to deal with. However, a large number of manufacturers, within the past three or four years, have been induced to adopt what may be called a trade refuse destructor, with very satisfactory results. In some works a vast quantity of combustible material is produced which can thus be readily destroyed on the premises, and, by putting down a steam boiler in connection, the resultant heat can be employed at any rate for such a modest purpose as heating water, or for heating the works during the winter months. In other very large works, where the quantity and quality of the waste material lends itself to useful steam raising, excellent results are being obtained; the imperfectly consumed fuel from the ashpits of the steam boiler furnace is being passed through the destructor also.

The practicability and utility of the trade refuse destructor should commend it to all large manufacturers who daily accumulate quantities of waste; when kept, it occupies space, and is very often dangerous. If removed, then this has to be paid for, and sometimes a gratuity in addition to cartage to get rid of same.

Snow.—With regard to snow, it is scarcely necessary to that neither in this country nor America has it yet been fo possible to burn this in destructor cells, although I have American destructor circular before me at present in which t makers claim that they can "burn water." While from time time audacious claims have been made on this side, we have s yet soared quite so high.

Excreta.—It will be seen that this is being successfully burned in some places, but with our sanitary progress the cremation o excreta in destructor cells will not be necessary to any serious extent in the future.

Market Offal, Carcases, etc.—A number of high-temperature destructors are dealing with this most objectionable class of refuse successfully and without nuisance. Needless to say, such refuse should be got into the fires as soon as possible after delivery.

Another successful method of dealing with offal, etc., is to treat same with live steam in a vessel so arranged that no fumes can possibly escape, except to be cremated. Reduction by steam has not been largely adopted, but, where properly arranged, is very successful.

METHODS OF CHARGING DESTRUCTOR CELLS.

Three distinct types of charging or firing cells are in use—(1) Hand firing, that is, feeding all the refuse excepting, of course, large carcases, by means of a special shovel direct on to the grate, just in a similar manner to which a fireman feeds coal into a boiler furnace. At first sight this would suggest itself to the lay mind as being very laborious and objectionable, but upon seeing the operation I think it will commend itself as being exceedingly simple and efficient.

Mr. Brierley Denham Healey, in a paper entitled "The Economical Disposal of Town's Refuse," read before the Society of Engineers, speaking of hand firing, said: "It is a proceeding which is not more laborious than top feeding, if proper arrangements are made for stowing the refuse as regards suitability of level and distance from the firing doors." Where hand firing is in use, it is usual to have the containing hoppers running parallel with the cells, at a convenient distance in front of firing doors, the bottom of the hoppers being formed by a sill, about 15 inches above the ground level; thus each shovel filled with refuse has not to be lifted from the ground level, but from such a height, corresponding with the grate level, as tends to make the operation easy.

Again, as the refuse is being taken from the bottom of the hopper all the time, the stalest material is being always dealt with first, as each cart arrives, the contents being shot into the top of the hopper, flush with the tipping floor. The claims made for hand firing are both interesting and reasonable.

(a) Extreme simplicity with the minimum of labour. Each shovel full can be thrown just where it is wanted. Thus a bare place—a hole in the fire—can be at once remedied, and thus an excessive amount of air can be prevented from rushing through at the point of least resistance, and tending to lower the temperature.

(b) It is further claimed that the very laborious work of levelling fires is avoided, as the fire can be so manipulated as not to require attention with tools.

(c) Lastly, it is said that hand firing ensures the refuse being more thoroughly burned, and also that it tends to prevent any serious fluctuation in temperature.

(2) Feeding through hoppers in crown arch of cell over the grate, or from the back on to a drying hearth, or secondary grate, the refuse then having to be raked forward on to the grate proper. This is more generally known as top feeding by hand. Here you have the oldest system of charging, and that most extensively in use, several makers having adopted one form or another of the top feed, slightly differing in detail, but essentially the same in principle. It has been the practice to tip the refuse on to the top of the cells, sufficient being dragged or shovelled forward to the mouth of hopper, then pushed in, and down on to the drying hearth, there to remain and evaporate its moisture until the grate proper is clinkered, then the mass from the drying hearth has to be dragged forward and levelled over the grate, this operation being done from the clinkering floor level—a heavy, laborious task.

(3) Charging from hoppers over the back end of cells, by means of travelling trolleys, or tanks with automatic outlets, sometimes known as mechanical charging apparatus.

Like the previous systems just dealt with, this system has its advocates, fully as confident also that this is the best mechanical charging, has a "catchy" sound about it, but, like the two types previously mentioned, the human element is an important factor. The question is, Does the mechanical miscellany really displace the human to any serious extent? One thing is certain—a destructor installation, however well managed, however carefully organised, seems to be more or less inseparable from dust and filth, and it is scarcely necessary to point out that a dust charged air, a handling of dust by mechanical means, at any rate, does not tend towards preservation of mechanism, and wear and tear must be a serious item. I recollect that some three years ago, when Mr. Richards, the City Surveyor of Sydney, was in this country, inspecting various destructors, he visited an installation where mechanical charging was in use. He ventured to suggest that such mechanism would not stand under such conditions. This remark was at once negatived, but by an awkward coincidence a chain snapped at that very moment, and Mr. Richards went away unconverted.

I merely mention this to show that there is, and must be by the very nature of things, an uncertain and unreliable element under such conditions as obtain in destructor works. In such work simplicity should be aimed at, providing, of course, that it is compatible with efficiency. The real value of any system cannot be settled by a casual glance, or by figures served up by this maker or that maker. The matter needs carefully looking into, and weighing up by those who have to decide, but by reason of conflicting claims halt between two opinions.

Deputations should examine inquisitively into the claimed merits of each system, bearing in mind, of course, relative capital cost, and also relative depreciation. The last named method of charging must necessarily mean increased capital cost, then will its adoption work out so economically and efficiently as to warrant the increased capital outlay. Again, what labour will it displace as compared with the ordinary top feed or hand feed?

Further, tipping of such material as refuse from one receptacle into another, in transit, from the collection carts to the cells, charges the air with fine dust. Each time the charge of refuse is dropped a cloud of dust is liberated, and it cannot be seriously urged that the process is free from nuisance.

Opinion is much divided as to whether or not any serious economy results from the employment of automatic charging apparatus. At first sight it would appear that the economic claim could be substantiated, but he who investigates the deepest will learn the most.

Those who have to decide should go into the rival claims very searchingly. Mere appearance should not be allowed to impress too heavily.

The great danger is that a destructor works, not being a very desirable place for the novice to spend much time in, is too often very hurriedly inspected. Deputations and visitors are often restless and anxious to get outside, unless they are consumed with zeal. The atmosphere of a destructor works often utterly fails to inspire searching investigation and free criticism.

Many years ago, an eminent statesman remarked that the system which cannot stand investigation is doomed. Needless to add, this remark did not refer to destructors, but how applicable it is? The author's suggestion as to thorough investigation must not be considered to apply alone to patent charging apparatus, but equally to every system, bearing in mind the pregnant observation of the statesman already referred to.

A flying visit—a superficial, hurried view means the mere acquisition of a little knowledge—that dangerous quantity, while careful delving into the subject would, in course of time, eliminate all systems of doubtful value.

To make fair comparison of the three systems of charging, as regards the actual cost for each ton of refuse destroyed, is somewhat difficult. Naturally, the rate of wages paid in different localities will vary considerably, as also the number of hours per day the plant is operated, the type of destructor employed, and the system of working, whether by 8 or 12 hours shifts, etc. Further, the composition of the refuse must also be a factor in this connection.

To enable some comparison to be made I have selected the following installations, which cover three methods of charging:—

TABLE OF COMPARATIVE COST OF VARIOUS METHODS OF CHARGING CELLS.

PLACE.	Type of Cell.	Method of Charging.	Quantity dealt with per 24 hours per cell.	Number of Shifts worked.	Rate of Wages.	Actual Cost per ton of refuse destroyed for labour only.
Liverpool ... (Latest extension)	Manlove ...	Boulnois & Brodie's patent charging arrangement	12½ tons	2·12 hours each	Not given	8¼d.
Shoreditch ...	Do. ...	Do.	10 ,,	3·8 ,,	1 foreman, 40s. 1 fireman, 35s. 3 labourers, 30s. 4d.	1s. 10·20d.
Cambridge ...	Do. ...	Do.	6 ,,	2·12 ,,	1 furnace-man, 4s. 6d. 1 charge-man, 3s 6d. 1 clinker wheeler, 3s 6d. 1 odd man, 3s. 6d. day	1s. 3d.
Oldham ...	Horsfall ...	Ordinary top feed	8 ,,	3·8 ,,	7½d. per hour ...	9⅜d.
Warrington ...	Beaman & Deas	Ordinary top feed	15 ,,	2·12 ,,	27s. per week ...	9½d.
Rochdale ...	Meldrum ...	Hand fired ...	23 ,,	2·12 ,,	6d. per hour ...	7½d.
Torquay ...	Warner ...	Warner's top feed...	8 ,,	2·12 ,,	3s. 4d. per man per shift	9·22d.
Hereford ...	Meldrum ...	Hand fired ...	20 ,,	12 hour shift	2 men at 4½d. per hour	9d.

Regularity in Charging Cells.—Although three distinct systems of charging cells are in vogue, yet whether the operation is done by hand or by mechanical means, it is nevertheless of great importance that a strict regularity in charging and clinkering be insisted upon. While it is common knowledge that such methods of working are very often much at variance with the ideas of stokers, in spite of this nothing should be allowed to prevent the work proceeding constantly with mechanical precision.

With hand firing the firing operation may be said to be practically continuous, but let it not be forgotten that where mechanical methods of charging are in use, the men have also to be reckoned with. The actual charging of the cell from start to finish can be no more regularly performed in the latter case without the man than in the former.

Having insisted upon the necessity for a regular cycle of operations, I will now proceed briefly to show why it is essential, and if not observed what is likely to result from such neglect.

Firstly, regularity conduces to the easy maintenance of a steady temperature, while neglect and rushing the fires has the inevitable effect of dropping very often hundreds of degrees in temperature. When this happens, then the destructor is put down as a nuisance, because cremation has been thwarted, and if it happens to be combined with a power plant, rapid fluctuations secure the condemnation of the destructor as useful in combination.

Secondly, such methods of working are the reverse of economical. Proper time is required to cremate the material. Waiting and rushing tactics will not do ; they approximate to the " murdering " of coal in boiler furnaces.

If we recognise refuse to be useful as a fuel, let us insist upon the fuel being burned economically, which simply means that it must be burned thoroughly at a high temperature. If stokers could only be brought to see it, surely they would recognise that it is easier to work comfortably and steadily always than to rest half of their time and work like slaves the other half. That, however, is their *modus operandi* too often, if they are not properly supervised, stupid as it may appear to be.

An essential in every destructor works is a leading stoker, who shall be held responsible for the men under him, but, of course, this is only possible in large works. It is with some of the smaller installations that nuisance has been most prolific. Some time since, the chief Smoke Inspector of Sheffield suggested to me, in course of conversation, a novel way of ending the smoke nuisance. I just briefly allude to it because it struck me as being not unsuitable for ending nuisance occasioned by destructors being improperly handled. Mr. Nicholson said that in the event of a smoke prosecution, if those appointed by the authorities were quite satisfied that the steam user had adopted a good preventative, and that he was not to blame personally, then the onus should fall on the fireman, and that the man who would not trouble to do his work properly, and use the means at his disposal, should be fined or imprisoned. This does not seem unreasonable, I think, and there could be no doubt that it would have the desired effect. The same method might also be employed with advantage in the case of destructors.

Where a leading stoker can be put in charge and held responsible, it is advisable, further, it is very useful, to employ a constant steam pressure recorder gauge, such as Crosby's. Then all that is necessary is to put in a fresh chart every 24 hours, and there is a continuous recording " tell tale " day and night.

The Alleged Dust Nuisance.—There can be no doubt that in the past great annoyance has been caused by the ejection of a quantity of fine dust from the chimney stalks of destructors. A few years ago, every report by a surveyor mentioned cases, sometimes many, sometimes few, where it was admitted that complaints had been lodged because of such nuisance.

With our improved methods, and in the light of present experience, the nuisance can easily be accounted for. Firstly, the cells were not properly designed ; secondly, little, if any, provision was made for facilitating the settlement of the dust in its travel, or for intercepting it in such a way that its progress was arrested, and causing it to collect in such a position that it could be readily removed ; thirdly, the high chimney, worked with the dampers full open, and combined with the other deficiencies, simply made nuisance easy.

Again, the high chimney has been blamed for nuisance sometimes when it has not offended, simply because dust of some kind has been seen, or an odour of some kind has been noticed, and as the high chimney is a prominent landmark and has been known to offend, it is at once credited with every bad smell and every small accumulation of dust.

The destructor chimney has been, and always will be, critically watched and borne in mind. Cases could be cited where complaints have been lodged, *re* alleged nuisance, before an ounce of refuse has been burned.

Mr. Stevenson Macadam, Ph.D.F.I.C., contributed some interesting information *re* dust from destructors, to the Journal of the Society of Chemical Industry. dated March 31st, 1896, which I will quote:—

"The dust must also be included as main factors in any nuisance from the operations of an inefficient or badly worked destructor. These dusts may arise : (*a*). From the charging sheds where the town garbage is thrown down from the carts. (*b*). From the furnace vaults during the drawing or discharging of the cells, and (*c*). From the vaults when water is thrown upon the hot debris, either by buckets or fire hose. In the latter case the clouds of steam are accompanied by much fine dust in suspension.

As a preliminary to the investigation of the destructor dust, and its identification from ordinary road dust, or even railway dust, when the destructor is placed in the immediate neighbourhood of railway lines, it is advisable to separate the coarser particles from the real fine dust, and that without any attempt to pulverise or reduce the larger pieces. This is most readily done by sifting the dust through sieves, and the trials made by me showed that a wire gauze sieve with 1600 meshes to the square inch, being 40 ins. by 40 ins., only kept back paper ash and loading, small stones, cinders, etc., and the real dust which was liable to be blown about readily passed through the meshes. Indeed, part of this fine dust would pass through a sieve with 6,000 meshes to the square inch. The proportions of 1,600 meshes to the square inch was found most suitable for working with all sorts of dust, whether destructor dust, road dust, railway dust, or field dust.

The identification of destructor dust may be carried out partly by chemical and partly by microscopic means. Firstly, it is found that when the dust is diffused through the atmosphere by sifting it through the fine sieve in front of the nose, the peculiar singed-like, fœtid odour characteristic of the destructor smell is distinctly observed, exactly similar to that noticed in the drawing vaults of the destructor. The same singed, fœtid odour is noticed on the person and clothes after each inspection of the apparatus, and when the mere running of the fingers through the hair, or the brushing or shaking of clothes, at once evolves sufficient dust to give rise to the peculiar characteristic odour ; secondly, when the dust is heated on platinum foil over a lamp, when the organic matter is burned away, with the same destructor odour ; and thirdly, when some of the dust is added to water, and the latter heated, when the steam evolved gives out a similar destructor smell.

Under the microscope, and using powers of 70 to 140 diameters, the destructor dust exhibits a marked lava-like appearance, or almost glassy structure of the fine particles, which is largely due to the disruptive action of the water thrown on the slaggy débris which had been withdrawn from the cells. The magnified particles are mainly jagged on the edges, and are very adherent, whilst here and there minute balls or bombs, and the moulds from which these have been blown, are observed. The same structure is observed when the dust is fully burned on platinum, or when heated with nitric acid to destroy the organic matter, which leaves a residue markedly siliceous, and glassy in texture and composition.

All of these general characters are observed in the dusts taken from the discharging vaults of a working destructor where water is thrown on the red-hot débris taken from the cells, as also from the dust collected from the outside yards and grounds, as well as from the fences and walls, as well as stems and leaves of plants examined in the neighbourhood, and even on the scum taken from a sheet of water situated 100 yards from the destructor.

The facility with which wind will carry destructor dust is even greater than in the case of ordinary road dust, for whilst the latter has a specific gravity of 2·34 (water=1·000), the destructor gas has a specific gravity of 1·989, being a difference of 0·445 less density, and being therefore about 20 per cent. lighter than ordinary road dust, the destructor dust, equally fine in particles, is more readily lifted by winds and carried in suspension. When deposited, however, as a layer on the leaves and stems of plants, the destructor dust adheres more firmly to such, owing to the jagged edges.

Ordinary road dust, when diffused through the air by sifting through the fine sieve, does not evolve any particular odour, and the same negative result is given when the road dust is treated with water. If placed on platinum and heated over a lamp, the road dust merely evolves a slight corky straw odour, and has no singed, fœtid smell. Under the microscope the road dust is observed to consist of small stones, somewhat rounded and weathered, with only an occasional fragment of jagged, glassy material.

Railway dust, as taken from the permanent way and from passenger platforms, when diffused through the atmosphere, yields no particular odour. When boiled in water it emits a slight sulphury smell, and when heated on platinum foil it evolves a burned coal odour, without any singed, fœtid smell. Under the microscope the fine particles are found to consist of minute cinders, and minute stone cinder and stone dust, with a few fragments of jagged, glassy material.

The same characteristics are observed with other railway dust, such as that taken from the top of railway tunnels, from the insides (not floors) of railway carriages, and from railway waiting-rooms.

The quantitative analysis of the various dusts also bring out the difference between destructor dust, on the one hand, and ordinary road dust and railway dust on the other.

THE DESTRUCTOR DUST taken from the drawing vaults outside yards and grounds yielded :—

12 per cent. to 15 per cent. of organic matter, and
50 per cent. to 55 per cent. of siliceous matter ;

and destructor dust taken from the leaves of plants (principally laurels) growing in the neighbourhood of a destructor gave :—

15 per cent. of organic matter and 55 per cent. to 58 per cent. of siliceous matter.

Whilst ordinary road dust yielded :—

2½ per cent. to 5 per cent. of organic matter, and

80 per cent. of siliceous matter.

And railway dust from the permanent way gave :—

10 per cent. of organic matter, and

fully 70 per cent. of siliceous matter.

It will thus be seen that dust from a destructor possesses an odour peculiar to itself, just as is the case with any noxious fumes emitted. To the initiated it is impossible to mistake this smell for any other smell, and there can be no doubt that it is extremely obnoxious."

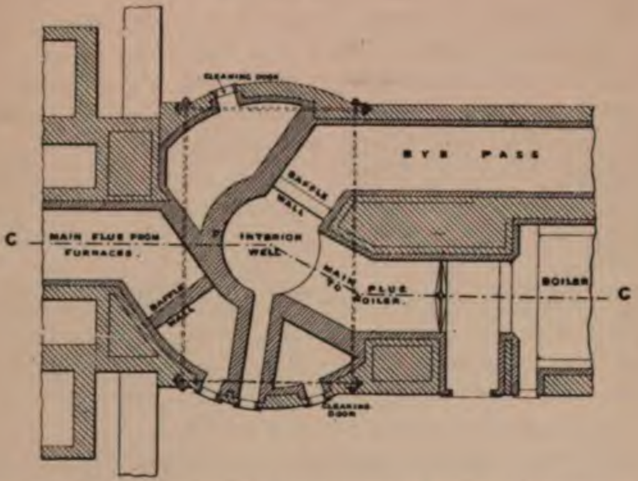


FIG. 72.—PLAN SHOWING GENERAL ARRANGEMENT OF HORSFALL'S DUST CATCHER.

Now, with our modern practice, it may be claimed that the ejection of dust is the exception, and not the rule. It has been conclusively proved that a properly designed plant, worked in a proper manner, will be absolutely free from nuisance of any kind.

How has nuisance been prevented? Simply by the application of common-sense principles, by leaving the minimum to chance. Dust must not escape! Therefore, it must be intercepted. This may be done by employing a simple arrangement of dust-settling traps, or by causing a settlement by centrifugal travel of the gases and dust ere it is too late. The interception of dust is facilitated by reducing the velocity of the travelling value of gases; again a common-sense principle is applied. Velocity is reduced by enlarging areas; then the settlement of dust becomes easier.

[1]A combustion chamber of sufficient capacity must be provided to allow an easy lodgement of dust there. Then the whole principle of design enters into the question; if the design is wrong throughout, obviously much trouble can be expected, flues may be altered and enlarged, but if proportion is ignored, trouble will surely ensue.

The advent of the high temperature destructor with artificial draught has been the means of ending the dust nuisance, generally speaking, the reason being that the refuse being burned independently of the chimney, it is possible to use this more as an exhauster. The chimney, if powerful, can be throttled and used just to gently pull the gases from the top of the fires. If, on the other hand, the chimney is a low one, it can be handled in exactly the same way, so controlling the chimney pull by means of the damper that any escape of dust is practically impossible.

It is useless to disguise the fact that, with every available means provided to obviate nuisance, even then we must be to some extent at the mercy of the human element. With a well-designed modern plant, however, very little scope is allowed for the man to cause nuisance with escaping dust.

Fume Cremators.—Although a number of these are still in use with low temperature cells, it may, I think, be said that their adoption in connection with new installations has now ceased, never to be revived.

A maker of destructors nowadays, who has the temerity to include in his offer cremators, tacitly confesses that his destructor is weak and unreliable; in short, it is outside the pale of modern practice. At one time a cremator was an accessory to a destructor, but that time has passed, and if a cremator is offered to-day as an accessory, it would be well to avoid that destructor and its accessory.

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[1] Sir Douglas Fox, in a report, estimates that ·18 grains of flue dust are contained in a cubic foot of air in the combustion chamber.

At least three cremators have been on the market :—

Pickard's Patent, No. 1,020, March 9th, 1880.
Healey's Patent, No. 7,703, June 25th, 1885.
Jones' Patent, No. 8,690, July 18th, 1885.

The last-named is the best known and the most extensively adopted.

Dr. Stevenson Macadam, Ph.D.F.I.C., contributed some very pointed observations on the cremator to the "Journal of the Society of Chemical Industry," March 31st, 1896. After inspecting a number of cremators, he reports as follows :—

> The difficulties connected with destructors in general for the thorough combustion of the refuse and the escaping gases into innocuous matters arise mainly from the varying conditions of any cell from time to time, so that even when it is possible to get up the proper temperature, when the cell is in full blast and in the cindering and clinkering stage, yet when the charging operations are proceeding, and for some little time thereafter, the temperature becomes lowered below what is required for efficient treatment of the refuse and its products.
>
> To overcome the deficiencies recourse has been had to the use of cremators, which practically form part of the main flue, and where a bed of red-hot coke or other fuel is supposed to be constantly burning, and over which the smelling gases must pass and ought to be consumed. The suggestion and construction of these cremators is an admission of the inefficiency of the destructor proper, and are a *mere whitewashing of an imperfect machine.*
>
> The cremators are costly in working, are not properly attended to, and, though I have repeatedly looked at them during my inspection of the destructors, and have even been told beforehand that they were in operation, I have never yet found one of them in actual full work, though otherwise they were in serviceable condition.
>
> A cremator should not be called upon to check or rectify the imperfections of any destructor, and the destructor proper should be capable of doing its own work.

The best modern practice shows that the destructor proper will do its own work ; that a cremator would be superfluous altogether ; and the remarks of such an authority as Dr. Stevenson Macadam only serve to show that if a cremator is offered as a necessary accessory to any destructor, that particular type should be severely let alone.

The foregoing observations were made in 1896, but even prior to that time, in the London County Council report on Refuse Destructors, issued in 1893, the cremator was condemned for similar reasons to those adduced by Dr. Stevenson Macadam.

Can it reasonably be expected, then, that any destructor in these days, which is still wedded to the cremator either as an integral part, or as an occasional safeguard, can hope to make any progress? Mr. Jones once said that a cremator may be found buried in Herculaneum. It has been contended by some, and not without reason, that the cremator even in its heyday was of very doubtful value. That there is some reason in this allegation must be conceded. Cremators were usually placed in the main flue, and powerful chimneys were invariably used ; it must then be allowed that the gases travelling from the cells over the cremator fires would have a considerable velocity. That being so, it is difficult to see how the cremator could have any serious effect upon gases travelling so rapidly.

The cremator was much in demand, however, when nuisance was rampant. Probably the writer of the following doggerel in Dr. Parke's "Chemical Catechism" was a sufferer :—

Must Britons be condemned for ever to wallow
In filthy soot, noxious smoke, train oil and tallow ?
And their poisonous fumes for ever to swallow ?
For with sparky soots, snuffs and vapours, men have constant strife ;
Those who are not burned to death are smothered during life.

One would almost imagine that something even worse than an old low temperature destructor minus a cremator must be responsible for the above.

Clinker Disposal.—Generally speaking the residuum from destructors varies from twenty-five to thirty per cent, and where modern high temperature cells are in use this clinker is vitreous and innocuous. In some places it commands a ready sale, in other places circumstances are such that the authorities have had the greatest difficulty in getting rid of it all.

There is no doubt that a great deal yet remains to be done in the useful employment of clinker; that it is a useful product has been amply demonstrated in several places, and it may be said that where this has been conclusively proved the authorities have most seriously tackled the subject, by erecting a complete plant for making pavement flags, concrete, and gravel. As a recent instance of success in the utilisation of clinker, probably nothing could be adduced to equal the record of Bradford.

A striking tribute to the ability of Mr. John McTaggart, A.M.I.M.E., the Cleansing Superintendent, is given, when the opponents of municipal trading instance the case of Bradford Corporation as unwelcome competitors.

While not expressing any definite opinion as to the rights or wrongs of municipal trading, there is this to be said, that if the residue can be so handled as even to partly pay for the destruction of the combustible, resulting in some gain to the community, then it is surely very commendable.

Mr. John McTaggart, of Bradford, has given this phase of the subject very serious consideration, and the results of his efforts are most instructive. Recently at the meeting of the British Association at Bradford, he read a very interesting paper giving detailed results of crushing test with cubes cut from concrete flags, transverse tests of concrete flags, and also crushing tests of bricks, the figures of these tests are here given :—

Analytical report by F. W. Richardson, F.I.C., F.C.S., upon two samples of clinker from Mr. McTaggart, for the Bradford Corporation.

	Fine.	Medium.
Siliceous matter	61·08	67·10
Iron and alumina oxide	21·50	19·30
Carbonate of lime	7·80	6·00
Magnesia	Traces	Traces
Organic and volatile matters ...	4·12	1·80
Moisture	5·50	5·80
	100·00	100·00

A specially interesting feature is the manufacture of bricks, these are the result of considerable experimenting, and they are now said to be very satisfactory indeed. For any class of inside walling they are very suitable, they can be produced in any shape or colour; the bricks are made from a ten per cent mixture of hydraulic lime and clinker, and it is claimed that when properly seasoned they are fifty per cent stronger than the ordinary building brick used in Bradford. Further, they can be manufactured at a cost of 14s. per 1,000.

Here would seem to be a remarkable outlet for large quantities of clinker, and Mr. McTaggart is to be congratulated upon the very successful outcome of his many experiments.

The question of clinker disposal is one which each authority must settle for themselves; with many it has been and is yet a serious problem. Until 1894 the cost per annum in Bradford for carting clinker to tips was over £1,000, certainly a very

Table A.—RESULTS OF CRUSHING TESTS OF CUBES CUT FROM CONCRETE FLAGS RECEIVED FROM BRADFORD CORPORATION.

Each cube was originally 2·5 in. in dimensions, and the area 6·25 sq. in. Date, August 10, 1900.

Test mark and number.	Description.	Maker.	Dates when made.	Ultimate crushing strength.	
				Total tons.	Tons per sq. ft.
1	Granite chippings and Portland cement. Proportion, 3 to 1 ...	Bradford Corporation	May 21, 1900	3·70	85·1
1a	... ...	" "	" "	1·48	34·04
2	Bluestone chippings and Portland Cement. Proportion, 3 to 1 ...	" "	May 24, 1900	8·02	184·46
2a	... ...	" "	" "	6·08	139·84
3	... ...	Hard Yorkshire Stone Company, Lightcliffe	Supplied to Bradford Corporation, March 7, 1899	14·59	335·57
3a	... ...	" "	" "	12·98	298·54
4	... ...	Threlkeld Granite Company, Keswick	Supplied to Bradford Corporation, March 4, 1900	8·10	186·3
4a	... ...	" "	" "	5·65	129·95
5	Destructor clinker and Portland cement. Proportion, 3 to 1 ...	Bradford Corporation	March 13, 1900	5·61	128·03
5a	... ...	" "	" "	6·56	150·88
6	Same as No. 5. Proportion, 4 to 1	" "	" "	4·06	93·38
6a	... ...	" "	" "	3·56	81·88
7	Facing-granite chippings and Portland cement. Proportion, 3 to 1 ...	" "	" "	8·24	189·52
7a	Body of slab-destructor clinker and Portland cement. Proportion 3 to 1	" "	" "	6·89	158·47
8	Same as No. 7. Proportion, 4 to 1	" "	" "	3·80	87·40
8a	... ...	" "	" "	4·38	100·74
9	Granite chippings and Portland cement. Proportion, 3 to 1 ...	" "	" "	8·68	199·04
9a	... ...	" "	" "	7·74	178·02
10	Same as No. 9. Proportion, 4 to 1	" "	" "	4·14	95·38
10a	... ...	" "	" "	5·25	120·75
11	Same as No. 7	" "	" "	5·79	133·17
11a	... ...	" "	October 23, 1899	5·79	133·17
12	Yorkshire stone slab	From Quarry Gap Quarries, Bradford	" "	17·87	[illegible]
12a	... ...	" "	... ...	[illegible]	[illegible]
13	Same as No. 7	Bootle Corporation	Supplied to Bradford Corporation, May 4, 1898 ...	[illegible]	[illegible]
13a	... ...	" "	" " ...	[illegible]	[illegible]

TABLE B.—RESULTS OF TRANSVERSE TESTS OF CONCRETE SLABS RECEIVED FROM BRADFORD CORPORATION.

EACH SLAB WAS ORIGINALLY 10 IN. IN BREADTH AND 2½ IN. IN THICKNESS. DATE AUGUST 11, 1900.

Test mark and number.	Composition.	Maker.	Dates when made.	Distance between supports in feet.	Total load.		Deflection at centre in inches.
					Tons.	Lbs.	
1	Granite chippings and Portlant cement. Proportion 3 to 1	Bradford Corporation ...	May 12, 1900	1⅝	·12	269	·18
2	Bluestone chippings and Portland cement. Proportion 3 to 1	Do.	May 24, 1900	Do.	43	963	·20
3		Hard Yorkshire Stone Company, Lightcliffe...	Supplied to Bradford Corporation, March 7, 1889 ...	Do.	66	1,278	·15
4		Threlkeld Granite Company, Keswick	Supplied to Bradford Corporation, March 4, 1900 ...	Do.	57	1,279	·11
5	Destructor clinker and Portland cement. Proportion 3 to 1	Bradford Corporation ...	March 13, 1900...	Do.	·52	1,165	·16
6	Same as No. 5. Proportion 4 to 1	Do.	Do.	Do.	·22	403	·16
7	Facing-granite chippings and Portland cement. Proportion 3 to 1 ... ... Body of slab-destructor, clinker and Portland cement. Proportion 3 to 1.	Do.	Do.	Do.	·66	1,478	·12
8	Same as No 7. Proportion 4 to 1...	Do.	Do.	Do.	·22	493	·15
9	Granite chippings and Portland cement. Proportion 3 to 1	Do.	Do.	Do.	·56	1,254	·10
10	Same as No. 9. Proportion 4 to 1	Do.	Do.	Do.	·22	496	·22
11	Same as No. 7	Do.	October 23, 1889	Do.	·25	560	·12
12	Yorkshire stone slab	From Quarry Gap Quarries, Bradford			1·11	2,486	·06
13	Same as No. 7	Bootle Corporation ...	Supplied to Bradford Corporation, May 2, 1898 ...	Do.	·68	1,523	·15

TABLE C.—RESULTS OF CRUSHING TESTS OF BRICKS RECEIVED FROM MR. JOHN McTAGGART, A.M.I.M.E., DESTRUCTOR DEPARTMENT, BRADFORD. DATE, OCTOBER 29, 1899.

Description.	Original Dimensions.				Ultimate Crushing Strength.				Remarks.
	Length in Inches.	Breadth in Inches.	Thickness in Inches.	Area in sq. ft.	Total.	First Crack Tons per sq. ft.	Completely Crushed Total Tons.	Tons per sq. ft.	
Ordinary Pressed Brick :—									
Sample No. 1	9·0	4·4	3·1	·275	36·31	132	50·76	184·6	Age unknown
Sample No. 2	8·9	4·25	3·1	·262			53·16	202·9	Age unknown
Destructor Clinker and 10 per cent. Portland Cement :—									
Sample No. 1	9·8	4·7	2·4	·32	19·61	61·3	24·84	77·6	Made
Sample No. 2	9·8	4·8	2·4	·33	9·86	30·2	24·49	75·1	10 weeks
Destructor Clinker and 15 per cent. Portland Cement :—									
Sample No. 1	9·3	4·6	3·1	·29	22·91	77·1	28·54	96·0	Made
Sample No. 2	9·3	4·6	2·0	·29	11·31	37·7	19·01	63·0	10 weeks
Destructor Clinker and 15 per cent. Slaked Hydraulic Lime :—									
Sample No. 1	9·9	4·7	2·5	·32	27·70	80·5	38·11	110·9	Made
Sample No. 2	9·9	4·6	2·6	·31			25·58	82·5	14 weeks
Destructor Clinker and 15 per cent. Unslaked Hydraulic Lime	9·6	4·8	2·8	·32	32·14	100·4	36·22	113·2	Made 14 weeks
Destructor Clinker and 10 per cent. Slaked Hydraulic...	9·9	4·9	2·9	·34	54·14	129·8	75·28	222·0	Made 18 weeks

All bricks were faced both sides with plaster of Paris and bedded perfectly true in the machine before applying pressure.

serious item to add to the actual cost of destruction, but so far as Bradford is concerned the problem is solved, and it is a splendid object lesson for other communities.

Mr. Brierley Denham Healey has estimated that if the clinker at existing destructor works was fully utilised £90,000 could be saved by making pavement flags, or if the clinker was only used for concrete and gravel a sum of £40,000.

There can be no doubt that the very attitude of many municipal engineers and surveyors towards the employment of clinker products for any class of work, under their own immediate supervision, has tended to cause the clinker to become a serious problem.

Where the municipal authority has set the example, outside customers generally seem to be prolific; on the other hand when the authority hesitates the outsider very often follows suit, and it is hardly to be wondered at.

Admittedly a great deal has been done in a small way in the utilisation of clinker, but undoubtedly there is a great future, and as any revenue obtained from this source will tend to materially reduce the cost of destruction, it cannot but be said that it is a matter of the highest importance.

With many authorities there is a great reluctance to embark in business as brick and tile manufacturers, artificial stone makers, etc., and it can be readily understood for reasons unnecessary to dilate upon here, that proposals with this end in view will in some cases be met with determined hostility. That will always be, but the general good of the community must eventually be considered.

One pleasing feature with regard to methods of clinker disposal, and in fact any municipal improvement, is that owing to that admirable professional courtesy existing among surveyors, cleansing superintendents, and other public servants, it is always possible for one community to learn and profit by the experiments or experience of another.

I am reminded of some remarks made by the ex-Lord Provost of Glasgow, Sir David Richmond, when welcoming the members of the Association of Cleansing Superintendents of Great Britain to that city last year. Sir David Richmond said :—" He invited those present to tell them something they did not know. He held it was the bounden duty of public representatives of the people to advise other public representatives in every way they could. He had no sympathy with one town crowing over another; they were elected to a very sacred charge, and advising each other was the best way they could serve the community over which they were placed."

With such a spirit as this actuating public officials, with successful experiments made in large and important cities, the disposal of clinker should pass from the problematical stage to that of practical realisation at a profit to the community.

REFUSE COLLECTION.

There can be no doubt that the type of vehicle generally employed for the purpose is by no means perfect. Far too many open vehicles are used, and where these have to traverse many streets in crowded cities, in hot or windy weather, much annoyance is caused by bad smells and filthy dust blowing about.

This very summer in the heart of the West End of London we have had an example of this, resulting in some angry letters published in the London daily press. There is much room for reform, not only in the type of vehicle, but in its rate of progress. Probably our slowest locomotion in London is represented by the dust cart; smarter collection is needed; and, when collected, let the contents be got out of the way expeditiously. By this last sentence I also mean that the rendezvous of the dust cart should be the refuse destructor. Depôts and sorting yards must exist at present, but they will not last, and, with their disappearance, a new era will be inaugurated — refuse will be destroyed where it is produced and not sent miles away, at a great expense, to be inflicted on other communities.

Recently, I was reminded of a somewhat interesting state of things existing near the shores of the wide reaches of the Thames. In the neighbourhood of Barking, Rainham, Tilbury, Purfleet, and Grays, enormous quantities of London refuse are tipped. One might conclude that with such an example before them sanitary authorities in the district would follow suit, emulating the unsatisfactory sanitary standard of the Metropolis; such, however, is not the case: the Urban District Council of Grays have decided to erect a destructor in connection with their electric lighting scheme. Some interest attaches to a case like

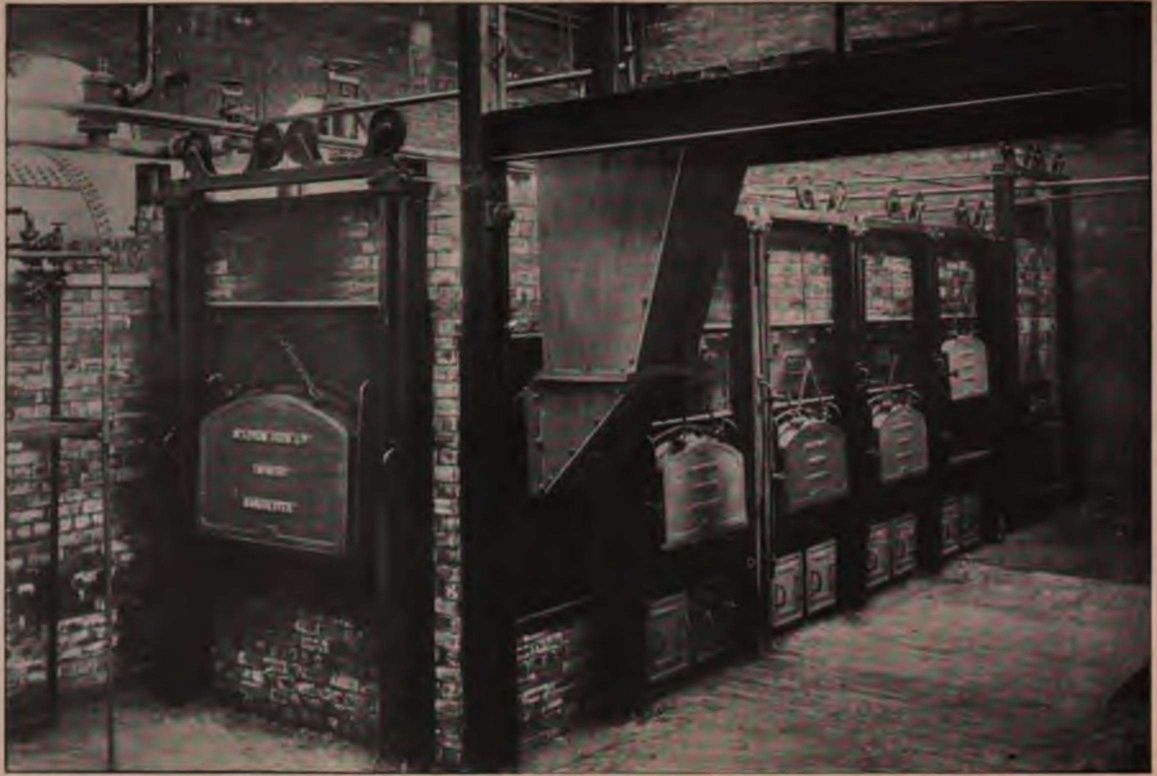

FIG. 73.—MELDRUM'S "SIMPLEX" DESTRUCTOR AT NELSON.

(To face page 312.)

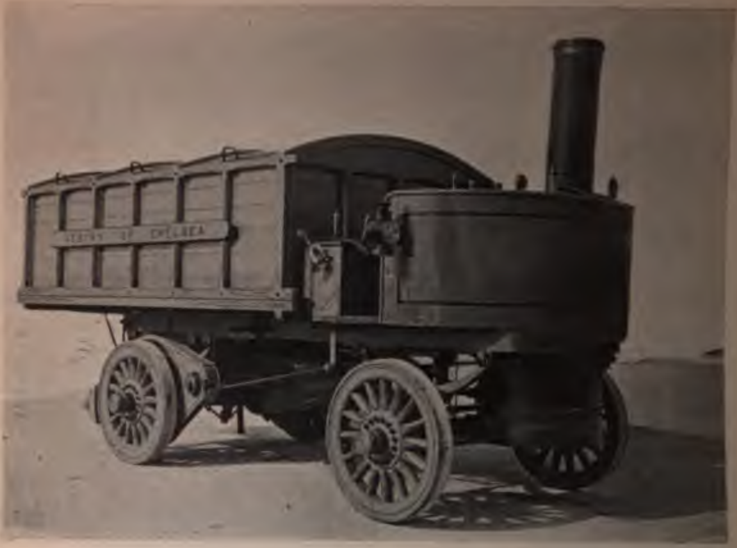

FIG. 74.—THE LANCASHIRE STEAM MOTOR CO.'S DUST WAGON.

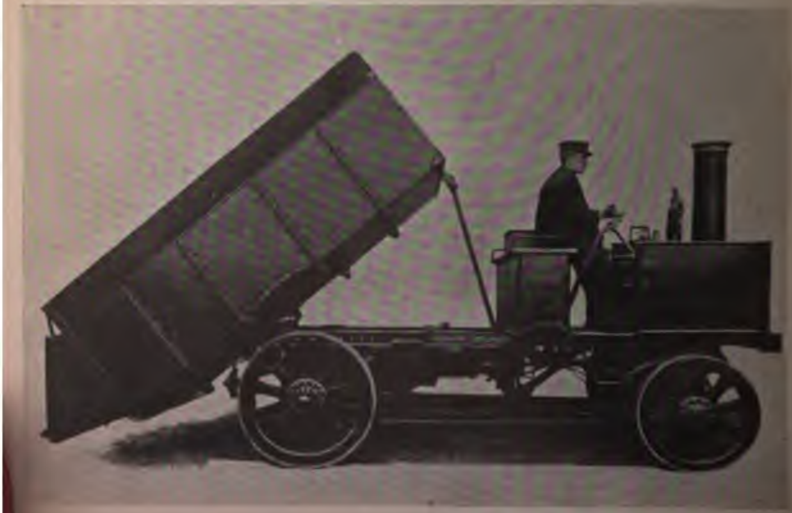

FIG. 75.—THE "THORNYCROFT" STEAM MOTOR DUST WAGON.

this, where a small town rising superior from the filth of London boldly adopts a combined scheme of destruction and power.

As already stated, many of the vehicles used for the collection of refuse are not by any means what they should be: they are cumbersome and slow, and it may be said that many are in use which cannot be called sanitary vehicles—in the sense that no effort is made to keep some of the refuse dust and odour from escaping.

Many of our London Vestries, however, are well equipped, and covered vehicles are in use, the carts are well kept, and the same may be said of the horses, which invariably make a good show at the cart horse parades. At the same time the vehicles are ponderous and painfully slow. Further, the system is costly, and it is this phase which I now purpose to consider briefly.

Ten years ago things were very different, but recent developments in automobiles would seem to point the way for radical changes in the collection of refuse, not only in a more speedy collection, but also in a more rapid delivery of the refuse at its destination; then last, but not least, there is the economic side of the question—it is claimed by the advocates of self-propelled vehicles that a very considerable economy is effected over horse vehicles.

Motors have not yet been adopted to any great extent for the collection of refuse and dust: the change is likely to be very gradual indeed, but the old method will surely have to go.

At the annual Conference of the Cleansing Superintendents of Great Britain, assembled in Glasgow on September 7th last, Mr. D. McColl, the well-known Cleansing Superintendent of Glasgow, moved the following resolution, which was unanimously agreed to:—

"That this Conference is of opinion that recent developments in the construction of motor vehicles justify the gradual introduction of self-propelled vehicles in several branches of cleansing operations, and this meeting recommends Municipal, Urban, and other Authorities to take the question into their serious consideration."

Glasgow, as usual, foremost and most enterprising, decided to try an electric dust van; Liverpool also tried a steam motor, of which Mr. John A. Brodie, M.I.C.E., City Engineer, speaks highly as to its efficiency and economy, although so far it has not been used for refuse collection. The work done during the past 18 months has been mainly in the conveyance of four-ton loads of tramway material and heavy stores.

The Strand Board of Works have experimented with a Board's Thornycroft Motor, which has been well tested in dust collection; also in flooding and watering the streets. Here will be seen some comparative figures as to cost of horse work and motor work in the Strand District :—

	£	s.	d.
Hire of five horses and harness (feeding and stabling done by contractors) at £65 per horse	235	0	0
Dust vans are owned by the Board, and used for other purposes			
Hire of two water vans, at £16	32	0	0
Three drivers of dust vans, at £71 10s. ...	214	10	0
Two drivers of water vans, at £84 10s. ...	169	0	0
Oiling and repairing three dust vans, at £8 ...	24	0	0
Third party insurance on five vans	7	10	0
Total reduction in cost per annum	£772	0	0

The expenditure in respect of the motor has been :—First period : Hire for eight weeks at £7 10s. per week, for day work only, inclusive of all charges. Second and third periods : These aggregate a clear three months.

The appended table, supplied by Mr. Ventris, is in proportion, and may be relied upon as being the outcome of experience :—

Estimated Annual Expenditure.

	£	s.	d.
Interest and return of capital, spread over 10 years, say	82	6	0
Fuel—			
36 cwt. per week, at 32s. per ton, say ...	150	0	0
Wages—			
Two drivers at 37s. per week	192	8	0
Attendant to work levers of water van on day shift, at 25s.	65	0	0
Repairs—			
Thornycroft's guarantee	75	0	0
Lubrication and waste	20	0	0
Boiler insurance on £2,000	33	4	0
Third party insurance	10	10	0
Total cost per annum ...	£598	8	0

Paper read by Mr. E. Shrapnell Smith, August 30th, 1900, at the annual meeting of the Ass Cleansing Superintendents of Great Britain, held in the Town H

The Chelsea Vestry made some experiments with one Lancashire Steam Motor, and decided to purchase two more, both of which will be delivered by this time. Another commendable feature about the motor van is its adaptability : thus a standard frame can be supplied upon which can be placed either a water tank, a dust van, a slop cart, an open platform or lorry, or even a sweeping machine, hence there is little occasion for a motor to be kept idle.

Yet another point is that motors reduce street cleaning and tend to improve the sanitary conditions of our thoroughfares, as they produce no droppings.

When we look back and consider what has been done in a comparatively short space of time with horseless vehicles, who shall say that our present system can last ?

Fire Bars.—A great variety of fire-bars have been tried for destructor cells, but generally speaking the outcome of much experiment has only been to bring us back to a plain simple stationary fire-bar, very closely related to the type with which we started.

At first sight the fire-bar does not suggest itself to one as being a thing capable of being conjured with to any extent, but experience has shown us some extraordinary creations. Some have been thin, others thick, while yet others have been hollow or cast in sections. We have also had fire-bars deep and shallow, long and short, some with the minimum of air space and the maximum of fire-bar, others vice versâ, and yet many more of the stationary type, far too numerous to mention here.

Of rocking or movable bars we have also had a variety—some driven from a cam shaft, others simply moved at intervals by hand levers. It may be said that movable bars have signally failed for destructor work. In some cases they have been given most patient and exhaustive trials, involving considerable expense ; but the end has usually been the same, a return to the simple fixed grate.

Of course some of the want of success may be accounted for by lack of interest on the part of that long-suffering individual, the stoker, but the fact remains that they have failed.

Rocking bars are costly, and they need attention. To put it briefly, they overstep that line of simplicity which is an essential for the class of work demanded from them.

Fire-bars galore have been introduced, and the field of invention and resuscitation has apparently not yet been exhausted. It is no exaggeration to say that, after many patient trials, many costly and vexatious experiments, we are again back where we commenced, and the old plain, ordinary fire-bar, with slight modifications, holds an unbeaten record.

Inclined Roadways.—Where cells are charged from above, the inclined roadway has been extensively adopted, although in a few recent installations an alternative scheme of directly raising the refuse from the ground level by hoists or elevators has been tried.

It is quite safe to say that inclined roadways are not likely to be used to anything like the same extent in the future. In the first place, they are in themselves a costly item. Secondly, considerable space is occupied ; and as destructors are being erected on centrally situated sites, the ground will be difficult to obtain at all, even if the figure is not prohibitive. Thirdly, the inclined roadway is at its best an ugly feature of a destructor works ; design it as you may, it cannot be made picturesque.

Against the disadvantages may be set one advantage—that of simplicity, but then the wear and tear in horseflesh is a considerable item, and must be considered.

If we now consider an alternative for a "top feed"—i.e., the hoist or elevator—here also expense has to be faced. Hoists use considerable power, whether steam, electric, or hydraulic ; they must be put down in duplicate in view of the evil day of breakdown and necessary stoppage for repairs.

Again, apart from this, ample working hoist accommodation must be provided to meet a quick and constant delivery of refuse. If this is not done, carts have to stand about, causing nuisance ; time is also lost, and the collection arrangements are disorganised.

Further, although the capital cost may be reduced, yet the item of depreciation must not be forgotten. When this system is decided upon, instead of an inclined roadway, on economical grounds, the purchaser would be well advised to have good hoists : these, like most other good things, are not cheap ; a cheap hoist is usually of very little service—it is unreliable, and what is saved in initial cost is speedily frittered away in repairs.

Generally speaking, so far, hoists have not been a great success, due largely to the fact that cheap jobs have been often asked for and accordingly supplied.

Hospital Refuse.—It is scarcely necessary to point out that this is a collection of filthy and dangerous material, and no reasonable person would for one moment suggest that any other method than cremation should be considered.

It will serve no useful purpose to enumerate all that goes to make up such refuse, sufficient to say that there are reasons which must be obvious to all why such material should be disposed of immediately and in a final manner.

The question of final disposal has received considerable attention in this country and also on the Continent. Our leading destructor makers all make hospital destructors, and they have been largely taken up by many important institutions throughout the country.

Some of the hospital destructors, unfortunately, are very crude; indeed, very little ingenuity has been brought to bear upon the general design, and generally speaking there has not been much improvement on the first cells erected.

This is to be regretted, but in the main I think it may be attributed to the fact that destructor makers have given most of their attention to the ordinary destructor—the larger job, where large quantities of refuse have to be treated.

I am led to the opinion by the fact that it is only within quite recent years that a destructor to deal with so small a quantity as ten tons of ordinary refuse per day has become at all common.

Even now it is often said that ten tons per day is too small a quantity to demand a destructor, or to warrant the necessary expenditure; then many urge that it is too insignificant a quantity to get any useful quantity of steam from.

I hope the reader will have seen sufficient instances and details of small destructors recorded in this work to quite satisfy him on that point—demand is the best stimulus to ensure a ready supply, and a large number of sanitary authorities with only five or six tons of refuse available per day are now considering the destructor question.

With the small refuse destructor—a proved success I believe—we are likely to effect considerable improvements in hospital destructors.

Generally speaking the intermittent operation of hospital destructors is not conducive to their efficiency, and tends to cause nuisance.

A hospital destructor in connection with a fairly large institution might readily be modified so that coke could be burned at such times as refuse was not available. A small boiler could be provided to supply steam for artificial draught : further a disinfector might also be operated in connection with the boiler, and when this was not required the surplus might be employed for heating or boiling water. Other outlets might also readily be suggested in a large institution. Such a combination would be found useful, and in maintaining the brickwork in an incandescent state nuisance would be obviated.

Another useful modification of the destructor, and one which we have not yet seen in this country, is the portable destructor. Some of our sanitary authorities in remote rural districts, responsible for the health of a number of small and isolated places, might usefully employ a good portable destructor. Such an arrangement, also, might commend itself to many hospital authorities, as the refuse could then be readily taken some distance from the buildings to be dealt with.

In America the question of disposing of the waste of such institutions has received considerable attention. Colonel W. F. Morse, of New York, has made a speciality of this in his sanitary consulting practice, the principle adopted being much the same as in furnaces for the incineration of human remains.

The use of a secondary fire or fume cremator, is insisted upon, and all the gases evolved must pass through this fire, which is so arranged that a steady temperature is maintained. The destructors are made in standard sizes, the smallest being of the following exterior dimensions :—6 ft. long by 4 ft. 6 in. high and 2 ft. 6 in. wide, and is specially intended for bacteriological laboratory work. This type is employed by the United States Government at the Laboratory Marine Hospital Service, D.C.

Larger destructors have been adopted by the Consumptive Home, Brooklyn ; Kingston Avenue Hospital for Contagious Diseases, Brooklyn ; the City Hospital, Boston ; Cornell Medical College, New York ; United States Government Quarantine Stations ; the Lessing Apartment House, Chicago ; New York

Lying In Hospital and Mount Sinai Hospital; St. Luke's Hospital, New York; City Disinfecting Station, New York; Hudson County Institutions, Snake Hill, New Jersey; Kings County Institutions, Brooklyn, etc., etc.

Most of the above are of fire-brick construction encased in a steel shell, and are connected to the ordinary chimney. Any available fuel can be used, such as gas, oil, coal, coke or wood.

Strictly speaking, more solid progress is being made in America with this type of destructor, than with the refuse or garbage destructor, the main reason probably being that the hospital destructor is not fettered with the trammels of that wretched contract system. Some of the hospitals named have had their destructor for ten years: it is part of the property and so not subject to such conditions as obtain in towns where a temporary destructor is erected under the contract system.

Sewage Sludge.—This very unpromising product is not burned extensively in destructor cells, and although it is now many years ago since Mr. Chas. Jones, at Ealing, demonstrated that the refuse of that district could destroy the sludge, very few authorities have decided to thus destroy their sludge.

At Ealing the sludge is not pressed, but simply dumped into drying beds of ashes, and after laying there for a few days to drain off the moisture, is then mixed with the refuse and fed into the cells.

The Urban District Council of Leyton have for some four years past been successfully disposing of sewage sludge cake in some Beaman and Deas cells. Some idea may be formed as to the awkward character of this sludge even, when it is said to contain about 65 per cent. of moisture.

Probably one reason why the destruction of sewage sludge in cells has made such little headway is, because, only two, or, at the most, three types of destructors in this country could deal with it at all.

Another reason may be because sludge which has been pressed is very easily reduced to powder, and in many places is in good demand for manure.

Of course such manure will vary in quality with the composition of the sewage, and also with the particular chemicals used for precipitation.

The treatment of sludge by evaporation is not favoured in this country, mainly because our climate is unsuitable for such a process. We are not blessed with a climate sufficiently dry, and, generally speaking, the land is too heavy for quick absorption, thus nuisance would soon be caused.

At Bolton Sewage Works Messrs. Meldrum Brothers, Limited, are erecting eight of Beaman and Deas cells to deal with sludge, and similar installations are contemplated at one or two other places, but with the development of the refuse destructor for power purposes, sanitary authorities do not seem to be taking at all kindly to the destruction of sludge, having in mind the fact that it is not a suitable material for power production.

Therefore, so long as any reasonable outlet can be found for the disposal of sludge by other means, destruction is not likely to be extensively adopted.

What Mr. Chas. Jones, of Ealing, said many years ago as to the refuse of the average community being capable of destroying its sludge, is perfectly correct, but the useful work to be obtained from refuse alone for steam-raising purposes is now so manifest to all, that sludge is not likely to be destroyed, excepting in some few isolated cases, where little outlet exists for the profitable utilisation of power.

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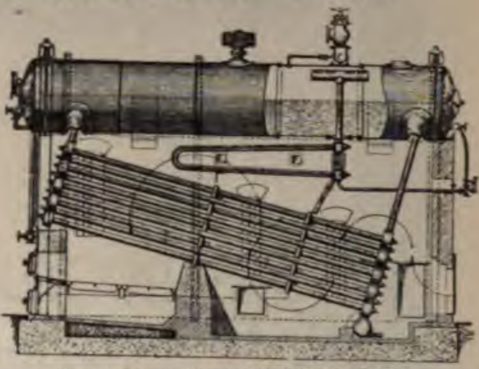

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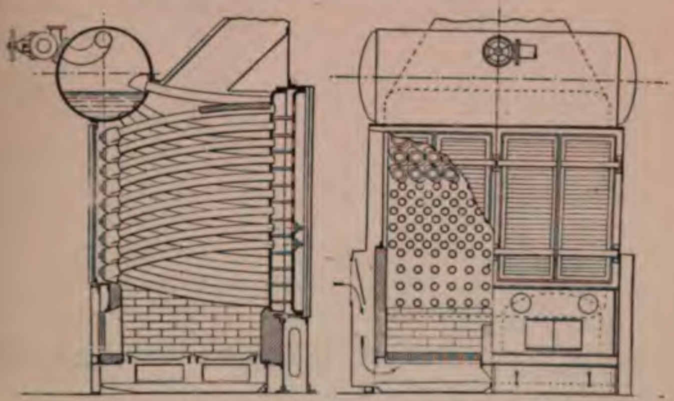

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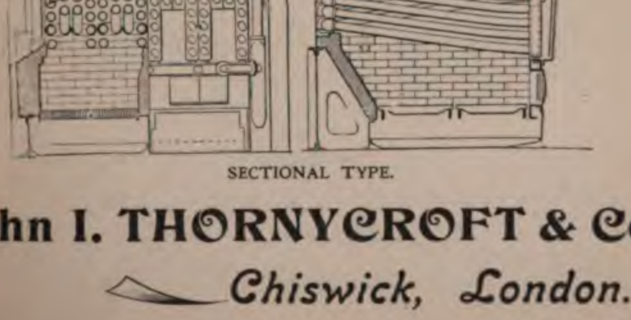

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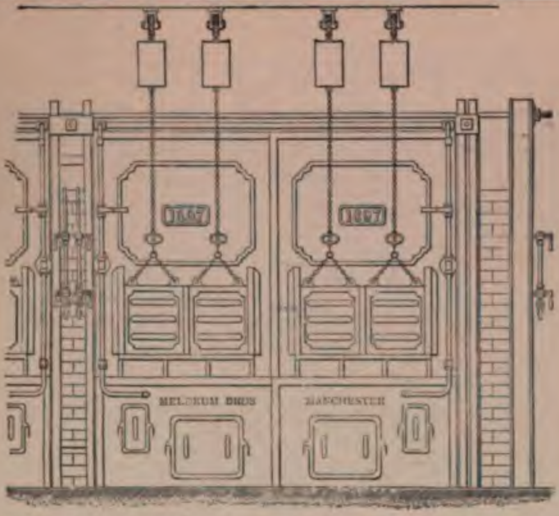

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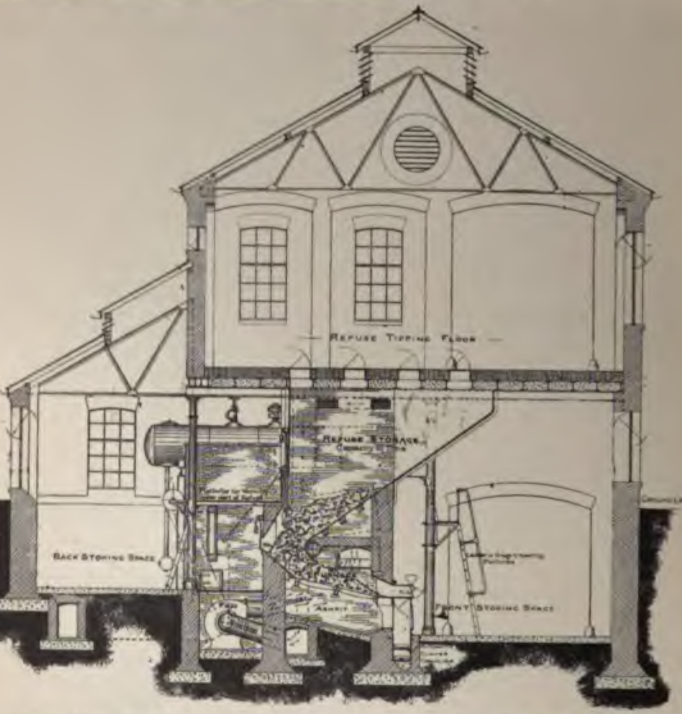

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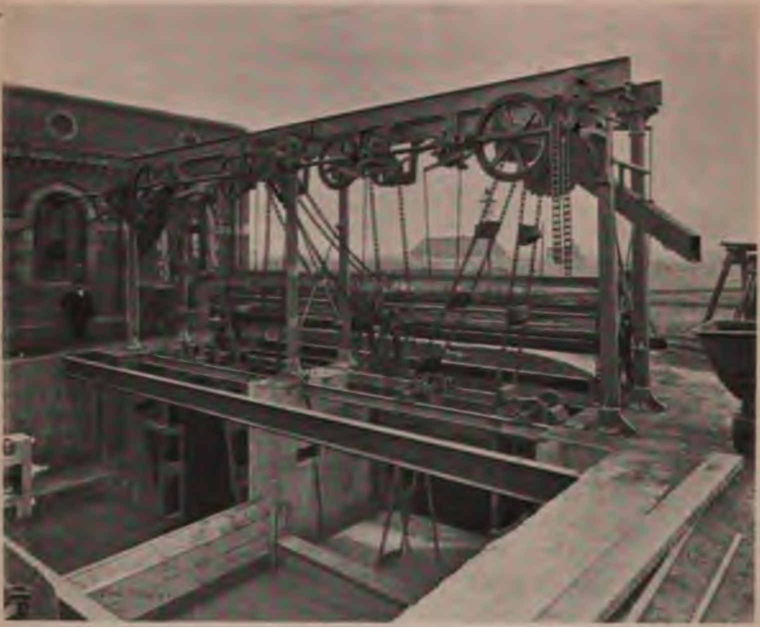

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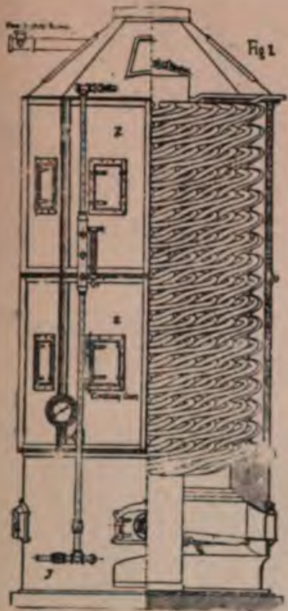

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